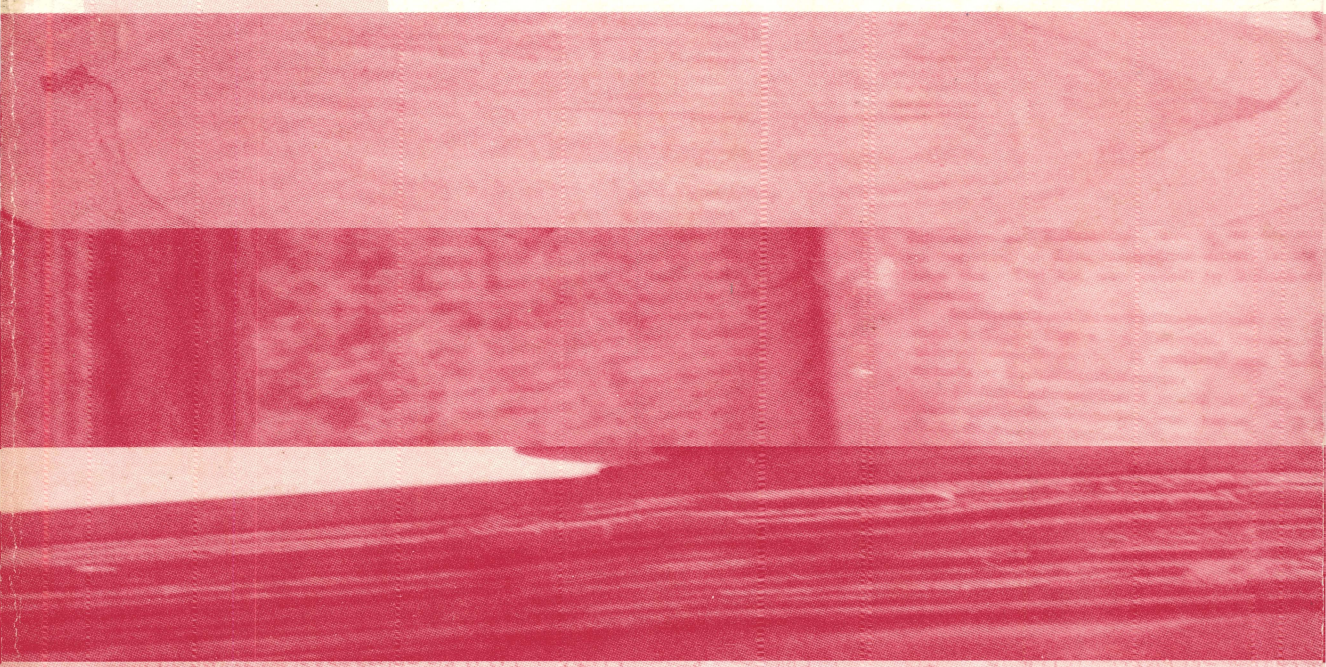
Care of ARCHIVAL MATERIALS AND MANUSCRIPTS



Dr. V. Jeyaraj

CARE OF ARCHIVAL MATERIALS AND MANUSCRIPTS

By

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FOREWORD

People express their feelings, thoughts and ideas in two ways. They are speech and painting (writing). Ancient man, who knew ancient writing on the walls of the caves, could not take those paintings from one place to the other. Therefore, from time immemorial materials like stone, clay tablet, metal, bark, leather, bone, wood, ivory, conch, shell, cloth, leaves, bamboo etc., had been used for writing purposes. Those expressed in writing are permanent. Today we possess many types of records, manuscripts, books, maps etc., on different support materials in archives, libraries, museums and associated institutions, temples, mutts etc.

Traditionally these written documents were preserved according to the materials available in the regions, techniques etc. Since India has a tropical climate, the materials of the past deteriorate very past. They need to be preserved. Even though many traditional methods are available, there are no standard methods to follow. The care and maintenance of records and manuscripts is a very important aspect of the archives, libraries, museums etc. This aspect was not ignored in ancient times also. This aspect is called preservation. Preserving our records, manuscripts, books etc., has been taken care of by the respective institutions with the help of the staff. Some archives, libraries, museums etc., find it difficult to take care of their collections as there is no staff earmarked for this purpose. In order to educate those who are in charge of the collections of manuscripts, books, records etc., Dr. V. Jeyaraj, Curator, Chemical Conservation and Research Laboratory, Government Museum, Chennai-600 008 is conducting many activities being a specialist in conservation of ancient materials. Sarasvati Mahal Library, Thanjavur is preserving thousands of manuscripts both on paper and palm-leaves. This library wanted to publish a book on care of the written materials. Mr. T. N. Ramanathan, District Collector and Director, Thanjavur Maharaja Serfoji's Sarasvati Mahal Library, Thanjavur requested Dr. V. Jeyaraj to write a book on Care of Archival Materials. The book was already prepared by him and it was made available to the Sarasvati

Mahal Library, Thanjavur for publication by the Library. It was published and released at Thanjavur during the Annual Conference of the Indian Association for the Study of Conservation of Cultural Property in India, New Delhi in 1999. The book on **Care of Archival Materials** and manuscripts was out of print for some time and many are in need of the book. Therefore, it was necessitated to reprint the book. Dr. V. Jeyaraj being the Curator of the Chemical Conservation and Research Laboratory, he is taking care of manuscripts on various support materials as the Coordinator of the Manuscripts Conservation Centre, Government Museum, Chennai-600 008 since 2004. He has carried out many activities related to the preventive and curative conservation of writing materials. He has incorporated the recent trends in conservation of records, library materials, manuscripts etc., and revised the book as Care of Archival Materials and Manuscripts.

This book will be a very useful one for those who are in-charge of records, library materials, manuscripts, antiquities etc., to practice both preventive and interventive conservation. The department of museums is very glad to publish this book for the benefit of those interested in the conservation of the written heritage for posterity.

Chennai-600 008,
21-2-2007.

(R. Kannan)
Special Commissioner and Commissioner of
Museums, Government Museum,
Chennai-600 008.

Acknowledgement

Taking care of the past records, manuscripts etc., is the foremost duty of the archives, libraries and related institutions. Some museums also do preserve such written heritage. Archives have the records of the past and the records and manuscripts are preserved for the posterity. Manuscript Libraries preserve manuscripts on different support materials. The knowledge of the supporting materials is very important for the conservation and restoration of the materials of the manuscripts. Different materials such as inorganic materials like clay, terracotta, stone, metals and organic materials such as bark, leaf, leather, stem, cloth, ivory, bamboo etc., have been extensively used.

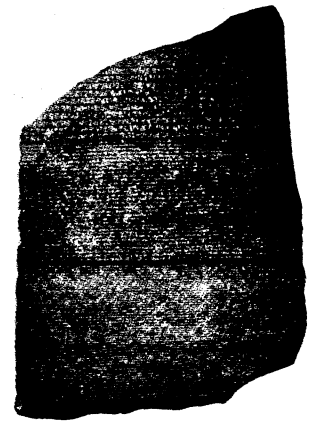
A course on Care of Archival Materials was conducted for the benefit of the archivists of the Tamilnadu Archives and Historical Research, Chennai in 1996. A book on Care of Records in Tamil was written by me and it was well received by those who are interested in the preservation of records and manuscripts. Therefore, the book on Care of Archival Materials was written in English and the same was published by the Sarasvati Mahal Library, Thanjavur. The book was on great demand and the same was exhausted soon. Dr. R. Kannan, I.A.S., Special Commissioner of Museums included the republication of the book for the financial year 2006-7. Since the book was in need of updating, I included support materials for manuscripts like bamboo, ivory etc. This revised edition was possible by the help rendered by Mr. K. Sekar, Curator for Children's Section, who was in-charge of publications, Mr. M. Girija Sankar, Photographer, Mr. J.D. Jagannathan, Mr. S.Senthilkumar, Mr. B. Thirunavukkarasu, Mr. M. Natarajan, Mr. J. Kumaran and others of the Government Museum and the technical support of Mr. K.K. Gupta, Consultant (Conservation), Mr. Abdur Rasheed, Conservator and Ms. Neeraja Gopi, Conservator, National Mission for Manuscripts, New Delhi. I also thank Mr. V. Mehanathan, President, Royapettah Stationery and Printing and Allied Producers Industrial Co-operative Society Ltd., Chennai-14 for printing the book. I hope this book will be used by those who are interested in the preservation of records, manuscripts, books etc., for posterity.

Chennai-600 008,
21-2-2007.

(Dr. V. Jeyaraj)

INTRODUCTION

History of Archives



Rosetta Stone, 196 B.C.,

Document is a record, which consists of information regarding administration, trade, etc. In the earlier days records were maintained in various ways. From time immemorial terracotta (Babylonians), papyrus (Egyptians), clay moulds (Harappans), bronze, bone, silk, wooden planks (Chinese and Osinians), palm-leaves (South East Asians, Indians) had been used traditionally as the base for writing and the records were preserved. Bhojpatthar was used in the northern parts of India for writing purposes. Even today, the barks of *agaru tree* and Aloe vera are being used for writing purposes in Assam. Stone inscriptions and copper plates were also types of records available throughout the world. India, especially Tamil Nadu, is not an exception to this. In the later days, paper is found much useful for making records. Present day records are on electronic media. Preservation is the passive protection of archival material in which no physical or chemical treatment to the archival material occurs. The records on all types of support materials need to be preserved for posterity.

Archives are institutions where records of the past and the present are preserved for posterity. The archives are of various types. The governments for the benefit of the people in the past established mostly the archives. Libraries are institutions where books are available for reading. Museum is a non-profit making permanent institution in the services of the society and of its development and open to the public, which acquires, conserves, researches, communicates and exhibits for purposes of study, education and enjoyment, material evidence of man and his environment. These institutions collect, preserve and publish information related to the past written heritage for the use of the present and past. They need to be preserved.

Athenians preserved their documents in the temple of the Mother goddess around 5th and 4th Century B.C. Roman Emperor, Justinian (527-565 A.D.) made arrangements for the construction of a building, an officer to be appointed to preserve them so that the records might not be damaged in the future. But, on 12th September 1796 as per the laws of the New French Government an archives in Paris was organised to preserve the records of the

Revolutionary Government. Later it was made as the French National Archives in 1796. In 1838, Public Records Office was established at London in England. In 1934, in U.S.A., the National Archives was established. In the Indian context the Imperial Records Office was established at New Delhi in 1891. Today, it functions as National Archives of India. In 1942, this Archives set up a Conservation Laboratory to take up research in the conservation of records. In 1919, Mr. J. A. Chopman, the Librarian of the Calcutta National Library got a Conservation Laboratory, which got facilities to preserve books. Even before our independence there were many archives in our country. The Tamilnadu Archives at Chennai is one of the State archives in the country. It was established in 1909 and the preservation of manuscripts is regularly carried out. To day it is called the Tamil Nadu Archives and Historical Research, Chennai. It conducts regularly a course for the benefit of the government staff in the maintenance of records. Conservation of records are being undertaken by these archives. Some have conservation facilities. But many do not have conservation facilities.

History of Manuscripts

People expressed their feelings, thoughts and ideas in two ways. They are speech and writing. Ancient man, who knew writing on the walls of the caves, could not take those writings from a place to place. Therefore from time immemorial materials like clay tablet, stone, metal, bark, leather, bone, wood, ivory, conch, shell, cloth, papyrus (a type of grass), leaf, bamboo etc., had been used for writing purposes. Those expressed in writing are permanent. Inscriptions are not easily destroyed in course of time. The writings on leaf, paper, bark, cloth, leather etc., are very easily destroyed as they are perishable. A manuscript is any written document that is put down by hand, in contrast to being printed or reproduced some other way. Manuscript means symbol. Since the scripts are symbols of sound spoken, they are called manuscripts. These manuscripts are not printed but handwritten. The manuscripts on leaves are called leaf manuscripts (*Yettuchuvadi*) in Tamilnadu, *Purja Pathra* in north India and *Thala pathra* in Deccan. The picture is the earliest Samskrit palm-leaf available.

Kushan Period Manuscripts, 200 A.D.

Institutions Taking Care of Manuscripts

There are many manuscripts and records preserving institutions in this country. Every State has State Archives of their own besides private organizations and libraries. Oriental Research

Institutes/Libraries such as Oriental Research Library, Tirupati, Bandharkar Oriental Research Institute, Pune; Oriental Research Institute, Baroda, Vrindavan Research Institute, Vrindavan are some of the institutions in other States, which are taking care of manuscripts. The Thanjavur Maharaja Serfoji's's Sarasvati Mahal Library has got conservation facilities. Theosophical Society, Oriental Manuscripts Library at Chennai; Aurobindo Ashram, Pondicherry; The French Institute of Pondicherry, The French School of Asian Studies, Pondicherry; International Institute of Tamil Studies, Central Research Institute for Siddha, Chennai, Institute of Asian Studies, Government Oriental Manuscripts Library, Dr. U.V. Saminatha Iyer Library, Kuppusamy Sastri Research Institute at Chennai, Thiruvaduthurai Mutt, Perur Tamil College etc., are showing much interest in the preservation of manuscripts in Tamil Nadu.

There are many laboratories, which are involved in the conservation of records, manuscripts etc. The National Archives of India, New Delhi; National Research Laboratory for Conservation of Cultural Property, Lucknow; Indian Conservation Institutes (INTACH) are some to mention. The Chemical Conservation and Research Laboratory of the Government Museum, Chennai, started in 1930, is doing both conservation and research activities related to archival materials and manuscripts besides conservation of all types of antiquities. It conducts conservation training programmes and various conservation activities. In 1997, the Curator of the Chemical Conservation and Research Laboratory conducted a one-week programme for the officials of the Tamilnadu Archives and Historical Research, Chennai on the care of archival materials. The National Mission for Manuscripts, New Delhi, which is a unit of the Department of Culture, Government of India, New Delhi established the Government Museum Manuscripts Conservation Centre at the Government Museum, Chennai in September 2004. It is providing both preventive and curative conservation of all types of manuscripts besides conducting many training programmes and workshops for those who are engaged in conservation as well as to those who are interested in the conservation of manuscripts and awareness programmes for the general public.

The sources of the written heritage viz. records and manuscripts are varied. They may come through exploration, through purchase, transfer, gift, confiscation, purchase etc. Government records reach the government archives by transfer of the records from the government. The archives are the storing places of the records. Once the records were taken care of by their own environment/owners; when they are brought to the archives, libraries or museums, a very few members of staff manage a large number of records, manuscripts or books. The

aggression/deterioration due to nature and human beings is high. In order to control the deterioration of the archival materials and manuscripts,

1. We must be aware of the factors of deterioration or dangers/aggressors.
2. The personnel of the archives/libraries / museums should be competent to handle the problems and
3. The conservators-restorers and the archivists or library/museum staff should be aware of the latest techniques of conservation and restoration.

Conservation Techniques

The various conservation techniques of the archival materials and manuscripts are:

1. Preventive Conservation
2. Curative Conservation
3. Restoration/Mending/Repair

1. Preventive Conservation

All forms of indirect actions aimed at increasing the life expectancy of (an) undamaged and or damaged element(s) of cultural property are termed as preventive conservation.

All the collection in an archives or manuscripts library or repository or museum are sound, stable and some are damaged. What ever may be the condition of the records, preventive conservation is essential. A team of people in an organisation may do this.

2. Curative Conservation

All forms of direct actions aimed at increasing the life expectancy of (an) undamaged and or damaged elements(s) of cultural property are termed as curative conservation.

In an archives, library, repository, museum etc., about 2% of the collection may be in need of curative conservation and restoration. When a unique piece is actively damaged, it needs curative conservation. It is an urgent and vital process to be carried out by a trained conservator/restorer.

3. Restoration

All forms of direct action aimed at enhancing the message(s) carried out by (an) damaged element(s) of cultural property are termed as restoration. About 10% of the records/ manuscripts in the collection of an archive/museum/library/repository are in a damaged condition. The priority of the treatment is secondary. A trained conservator, restorer, mender etc., may do the restoration. Some manuscripts are in need of only conservation. Some manuscripts are only in need of restoration. There are manuscripts, which are in need of conservation and restoration. The message from a record/manuscript should be communicated to the onlookers and also they should be protected.

The archivists, librarians or curators are all not much aware of the damaging factors of the manuscripts. There are very few cases, where manuscripts are miraculously protected without the help of any direct or indirect action. If the archivists, librarians, curators discuss the problems with the conservators, most of the manuscripts will be better preserved.

In order to increase the life expectancy of a manuscript, one must know the life history of the manuscript. The physical integrity of the manuscript is 100% at the time of its creation. When a metal manuscript completely degrades, there is no metal core but the form of the metal manuscript is maintained. Eventhough there is deterioration, the life expectancy may be increased further by conservation measures.

When a manuscript comes as a gift or collection, or at the time of accidental finding, it is found under a deteriorated condition. By the application of preservative measures, the life expectancy may be improved, reduced or will be reduced at the rate at which it originally deteriorates.

Aggressions of Cultural Property

The aggressions or the deteriorating factors of a manuscript can be natural or man-made. They may be by the environment, building or staff or combination of one or more factors. The natural aggressions may lead to immediate destruction or progressive destruction.

Immediate Destruction

Immediate destruction to the records, manuscripts etc., may be brought out overnight by flood, fire, earthquake, insects or by human beings in the form of deliberate braking, theft etc.

Progressive Destruction

Progressive destruction is also a natural one. This is brought about by environmental pollution due to air, dust, moisture, heat, light, micro-organisms, wind, salt and intrinsic factors like chemical changes with in the material, physical changes etc. The man-made aggressions are classified as public aggressions and professional aggression.

Public Aggression

Public aggression is mostly due to unawareness. They are such as vandalism, tearing of leaves of books or manuscripts, mishandling, neglect, carelessness, ignorant of the preservation measures to be taken care of as regard to manuscripts and records.

Professional Aggression

The aggression due to the professional mishandling of the archival materials, manuscripts, records etc., is called professional aggression. This is due to the lack of awareness, planning, training, security, control and improper execution of curative conservation, restoration or transport, storage, exhibition, support, lighting, handling, maintenance etc.

Strategy for Preventive Conservation

For better conservation of the cultural property, a systematic strategy is to be adopted. There are seven steps for the preventive conservation measures to be taken. They are:

1. **Know** the collection
2. **Know** the enemies (**Categorize** and **identify** the aggressors)
3. **Avoid** the aggressors
4. **Block** the aggressors
5. **Check** or **monitor** the aggressors
6. **React** against the aggressors
7. **Communicate.**

The preventive conservation measures may be taken on the above lines.

Preventive Measures

The archivist, librarian or curator in consultation with the conservation scientist/conservator/ restorer must determine the degree to which a collection is to be handled and the stack or display area and storage arrangements must be made available to the demands made upon it.

1. Correct levels of heat and humidity by air-conditioning; improvised microclimate through good building, designing etc.
2. Well planned storage areas with proper display materials.
3. Protection from light: correct levels of light; UV cutting films, window-blinds and curtains.
4. Use of proper conservation techniques and materials for housing the materials.
5. Full instructions to those connected with the collections such as proper maintenance, upkeep, usage etc.
6. Correct handling, no smoking, avoiding pens or inks.
7. Clean surface for avoiding deterioration.
8. Cleanliness of the environment.
9. Use of facsimiles, floppies, CDs, pen drives etc., instead of the original materials where ever necessary.
10. After the office hours the mains should be switched off.
11. Water and drain-pipes should not be laid in the rooms where stacks are located.
12. Cross ventilation should be provided in the libraries and archives.
13. Sun breakers or rain shades should be provided for windows to avoid direct sunlight and rain entering in to the hall where manuscripts are displayed or stored.
14. It is advisable to have one fire extinguisher per every 10 metres of length.
15. It is better to have good architecture of the building to house the archival materials/ manuscripts/ books.

ENVIRONMENT FOR RECORDS AND MANUSCRIPTS

Environment is the sum of all external factors, both living (Biotic) and nonliving (Abiotic), to which an object is exposed. Biotic factors include influences by members of the same and other species on the development and survival of the individual object. Primary abiotic factors are light, heat or cold, water, atmospheric gases, and ionizing radiation, influencing the form and function of the individual object.

Physical Factors

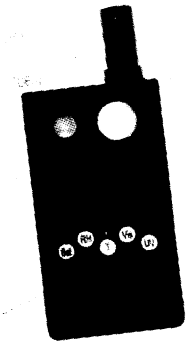
Light

Organic materials like paper gets deteriorated either visibly or invisibly when it is exposed to light whether natural light or artificial light. *Browning* of paper is a visible change. But, damage to the fibres resulting in *embrittlement* is an invisible change. But, when they break we worry. This embrittlement is due to the action of UV light on the fibres. The long chains are broken and paper is damaged. The amount of damage depends on the following factors:

1. Intensity of light
2. Exposure time
3. Type of light
4. Absorbency of light

Visible light is a very damaging factor, which causes deterioration to the cellulose materials. The pigments are discoloured. The chains of chemical compounds are badly damaged. Therefore, it is necessary to avoid light especially sunlight on the archival and library materials, manuscripts and other support materials. The spectrum of electromagnetic radiation reaching the Earth's surface is determined by the absorptive properties of the atmosphere. The most important spectral range is 300–800 nanometers, incorporating ultraviolet, visible, and infrared radiation. Ultraviolet radiation has the ability to break chemical bonds and so may lead to damage to proteins, lipids, and nucleic acids. Ultra violet light is a part of light, which damages archival materials and manuscripts. Therefore, the windows may be provided with coloured curtains, which will avoid light as well as absorb ultra violet light. The UV light cutting films may be provided to the fluorescent tube lights. It should be noted that incandescent lamps are better than tube lights. Nowadays fibre optics is gaining importance, as they do not emit heat and harmful rays. The light

intensity should be controlled inside the racks in the stacks and storage. 50-lux light level is sufficient for records. It is better to monitor the light level regularly using Lux Meter. UV light monitor may also be used to monitor the UV light level. The direct sunlight should never be allowed to fall on the paper materials. The direct sunlight will have an intensity of over 20000 lux, which is very dangerous. When manuscripts are given to the readers for reading, it should be noted that they should not keep under the sun and also in a place where the light intensity is high. It is advisable to keep the paper manuscripts under cover, if not used.



Universal Monitor

The exposure of the manuscripts to light will damage them. Maps should not be hung in direct sunlight, there by avoiding both excessive heat and harmful light rays. Regular glass helps some for ultraviolet light protection, and ordinarily there is no need for special glass coatings for framing (not every item needs to be in a specialized map room with paper conservators on call). Rotating the location of hanging maps, or display of manuscripts perhaps on a yearly basis, may prevent defects from resulting from uneven light or temperature exposure.

The unit of light is lux. 17-lux light is sufficient for visibility. We may allow 50 lux light where manuscripts or archival materials or other organic materials are preserved. We may use UV absorbing films where tube light is allowed. By using spectro-radiometer the intensity of light, amount of UV light can be measured. By controlling the light the damage to the archival materials may be reduced. Therefore it is needed to monitor the amount of UV light which falls on the archival materials. The permitted amount of UV light is 75 μw/ lumen.

Air Pollution

Air pollution is a problem. But if the archives, library or museum is in a heavily industrialized area, air pollution may not be easily avoidable. As always, basic climate control helps. Not all collectors, archives, libraries and museums can afford specialized air flow and filtration systems, nor are they always necessary. Nitrogen is a harmless gas as far as paper conservation is concerned. Oxygen helps in the oxidation of the fibres in paper. The damaging gases in the atmosphere are chlorides, oxides of carbon, nitrogen and sulphur, hydrogen sulphide,

hydrocarbons, etc. In most of the cases oxides of carbon, nitrogen and sulphur form the corresponding acids and are absorbed by the archival materials and the acidity of the archival materials is increased. The lignin present in the paper gets oxidised and affects cellulose thereby paper gets deteriorated. Ultimately they are prone to damage. When air-conditioning is resorted to, provisions should be given to absorb the harmful gases and to send good pollution free air inside and the air-conditioning should be 24 hours a day.

Heat

Heat is responsible for many damages in archival materials and manuscripts. Because of direct sunlight, lamps, and movement of large number of persons the temperature increases in a room. There are institutions where limited persons are allowed at a time. The temperature should be maintained at 19±1°C. If there is proper circulation of air, the temperature is maintained. Because of heat, materials expand and contract depending upon the environmental conditions. Because of this, book binding paste cracks, paper, leather, parchment etc., wrinkle. The temperature should be maintained at the ideal condition. Air-conditioning is the only way to maintain the temperature. But, round the clock air conditioning is costly and failure free electricity is also not ensured. Even if the air conditioners are provided there are difficulties to maintain the temperature in the rooms. It is essential to monitor the temperature round the clock to enable controlling the temperature. Any archives or library or museum must have the equipment such as thermometer, thermo hygrometer etc. Alarm systems are also available if there is breach of temperature level. If air conditioning is not provided for 24 hours, it is better not to use it. There are certain institutions thinking of air conditioning their rooms only during working hours. It is dangerous, as frequent change of temperature will be created, which will damage the materials. It is better to have free flow of filtered air to avoid dust inside the stack room or gallery and reduce the temperature in the halls/rooms.

There are two scales to measure the temperature. They are degree Centigrade and degree Fahrenheit. There is a conversion formula to convert Centigrade into Fahrenheit. The following formula can be used for conversion:

°C X 9 / 5 + 32 =°F

E.g. 30°C = 30 X 9 / 5 + 32 = 86°F

The conversion formula to convert Fahrenheit to Centigrade is

°F - 32 X 5 / 9 = °C

E.g. 86°F - 32 X 5 / 9 = 30°C

Relative Humidity

Relative humidity is the measure of moisture in the atmosphere at a particular temperature compared to the saturated condition at the same temperature. It is measured in percentage. The relative humidity ranges from 0 - 100%. Lower the value drier is the condition, higher the value more humid is the condition. Higher relative humidity is unfavourable for the upkeep of archival materials. If the moisture content is more, the organic materials absorb moisture and expand. The ink may spread, insects and fungal growth will damage them when high humidity exists. Because of the fluctuation in relative humidity, the archival materials will expand and contract weakening the archival materials. If the windows are provided with curtains they will absorb moisture. If the racks are covered with cloth the effect of moisture can be reduced at the same time dust also will be avoided. In the summer if *cus-cus* made curtains may be suspended outside the windows and kept wet, they will send cold air to the halls. Trays containing water may be kept in the comer, which will facilitate moisture in the room during summer. There are humidifiers, which will increase the moisture content to the required level. There are also dehumidifiers, which remove moisture by heating. These may be operated whenever necessary for which proper monitoring of relative humidity is highly essential. Air-conditioning the halls round the clock will help in maintaining the relative humidity. The ideal relative humidity is 50±5%. There are various devices, which could measure the relative humidity. They are called hygrometers.

There are manual, recording and electronic devices to record the relative humidity. Alarm systems are also available in case the relative humidity breaches the set range. Whirling hygrometer, wet and dry bulb hygrometer can be kept at any archives or library or museum without much financial commitment. In this case both dry and wet bulb temperatures should be measured and the corresponding value of difference in the wet and dry bulb reading against the dry bulb reading in a given chart will give the relative humidity at the temperature. The hair hygrometer will give the direct relative humidity but it will not record the value. There are recording type hygrometers, which will function for a weak. The relative humidity will be recorded round the clock for a week in the graph fixed to a drum, which

rotates similar to the time clock. There are electronic devices available, which record relative humidity and the same is recorded. The monitors are fixed which will measure and indicate the relative humidity. If we fix all these equipment our duty is not over. But, we have to be very cautious in controlling the climate suitably. Archival materials affected by water may be dried under air circulation. Rare manuscripts may be dried, in a box, keeping dried silica gel with blue indicator. Normally, the dry silica gel will be blue in colour. When it completely absorbs moisture, it will appear pink in colour. One cubic metre showcase may be in need of about 2 kg of silica gel. Heating may rejuvenate the silica gel. Trays with perforated sheets may be used for this purpose.

Dust

Dust is a very bad element of the atmosphere, which affects archival materials. Industrial areas and areas of very high vehicular traffic provide very high amount of dust in the atmosphere. Dust accumulates on the archival and other cultural materials. If not removed dust becomes dirt forming a part of the archival materials. Normally, floors are swept with brooms. It is not a good system of removing dust. Sweeping makes the dust to go up and settle on the materials. Only vacuum cleaning is the best method of removal of dust. Windows may be provided with dust filters. Exhaust fans also may be provided with necessary filters, which will not allow dust inside halls. When air-conditioning is done, we should provide proper dust filters, which will filter the dust to the maximum extent. Along with the dust bacteria, spores of fungi etc., are also removed. The chemical particles, ash, carbon, soot etc., got relieved. Some old buildings also contribute a great amount to dust. They should be repaired. New buildings should be allowed for seasoning at least for few months.

Acidity

The stability of paper mainly depends on the raw materials of the paper. The acidity acquired by the paper, damages paper and other archival materials. The acidity is acquired by the archival materials either by the action of the chemicals used for paper making or due to the chemical action with the environment for many years. The dissolved acid fumes in moisture are absorbed and acidity is increased. Carbon-dioxide forms carbonic acid, oxides of nitrogen form nitrous or nitric acids, oxides of sulphur form sulphurous or sulphuric acids and these acids are absorbed by paper and their acidity is increased. Because of the acidic contents of

the locality and using acidic papers, cardboard and other materials, the manuscripts or archival materials acquire acidity. The acidity of papers can be inferred from the colour change to brown and also by an acidic smell emanating from them. The acidity is measured by the pH scale, which ranges from 0 to 14. The pH is nothing but the hydrogen ion concentration in the material in the moist condition. If the pH is less than 7, it indicates acidity. If it is 7, the solution is neutral and when it exceeds 7, the solution is alkaline.

pH Pen

Measuring pH

The pH can be measured by various means. The pH paper may be kept at an inconspicuous comer of the document after wetting the surface. From the colour change (pink for acid and blue for alkali) and comparing the colour with the pH paper colour chart, the pH of the paper can be found out. The pH of the paper may be found out from the washings of the paper by using pH meter, pH pen etc. There are different types of pH pen which can measure the pH by wetting the paper. Because of the ultraviolet rays oxygen is converted into ozone. Ozone damages the bonds between carbon and hydrogen in the cellulose of paper and weakens the paper.

Removal of Gases

Gases, which affect paper, may be removed from the room by various means. The unwanted gases in a room may be removed by dissolving them in water or adsorbing them in solid surfaces or chemically changing them. Therefore, when a room is to be air-conditioned the devices, which can remove the unwanted gases, should be fixed. By fixing carbon filters, sulphur oxides, ozone etc., may be filtered. Oxides of nitrogen, carbon, sulphur, etc., may be absorbed in water if air is sent through water. The chemical solutions used for absorbing the gases should be changed at regular intervals.

Dangers of Biological Agents

In the tropical climate, plants like fungi and moulds and animals like bacteria, insects and rodents affect the archival materials and manuscripts when they are moist and hot.

Fungi

The fungal spores are present in the earth, water and air. They will be dormant at any environment. But, the spores sprout and grow when they have the required moisture and heat. They are found in different colours. Mould grows best in an environment with high relative humidity. When the relative humidity exceeds 70% and the temperature reaches 25°C or more, mould growth speeds up considerably. As certain fungi are responsible for certain decease to those who handle the affected paper materials, they should be carefully handled. Fungal attacked paper, archival materials appear black and are found to be weak.

Insects

Even though, there are thousands of insects, only certain insects badly damage the archival materials. They are silver fishes, cockroaches, book lice, bookworms, termites, beetles etc.

Insects

Silverfish

Silverfish and similar insects are affecting materials in houses, museums, libraries, archives etc., which are located in the tropical climate. They do not have wings. Silver fish is normally about 1 cm long. They eat the surface of paper, resin and paste from bookbinding. Their life cycle is two to three years.

Beetles

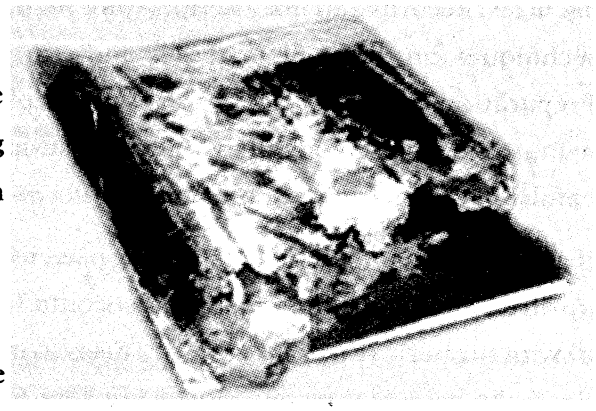
These types of insects make noise. They affect the cloth used in binding and paper. There are many varieties of beetles. They live in dry and hot climate.

Bookworms

Bookworms (*Gastrallus Indicus*) affect very much books and manuscripts. The larvae travel from the surface of the manuscript down to the bulk of the volumes and cause damage in the form of pinholes and this act is called *tunneling.*

Cockroaches

Cockroaches multiply in the temperature range of 20-29°C. They affect paper and leather binding much. They eat the resin and adhesives used in bookbinding with a great liking for the paste.



Termite Attacked Manuscripts

Termites

In the tropical climate, the damages to the archival materials due to termites are much. They live in wood and also on organic materials like manuscripts. In order to avoid the termite attack a suitable termicide is applied. Similar treatment is given to the other side and dried under shade and the edges are trimmed. This can be also done with chiffon and *maida* flour paste, which is mixed with an insecticide like formalin. In some archives copper sulphate is used as an insecticide. But copper sulphate in due course will produce acid which is detrimental to the paper manuscripts. It is found that chiffon mending with *maida* flour paste is found to brittle in few years.

Rodents

There are different types of rodents. Among them mice and rats are common. They destroy generally books, documents, manuscripts etc. Rodents such as rats and mice can eat archival materials and use papers to build nests. They also chew electrical insulation, which can result in short circuits and fires. If rodents are in the building, they are best caught using traps. Poisons will kill rodents, but if the dead rodent cannot be found, the rotting carcass can attract other rodents, making the problem worse.

TRADITIONAL METHODS OF PRESERVATION

The art of preservation is as old as human civilization. Our forefathers have selected suitable materials for keeping records and imparting durability to them against various deteriorating agencies. Records and manuscripts were prepared in different methods, written by different techniques on different materials and stored according to the practice of the locality. Preparation of manuscripts varies from place to place.The indigenous paper based manuscripts were generally with rough surface texture, sized with yellow arsenic and an emulsion of tamarind seeds (*Tamarindus indica*) acting as a smoothening agent.

If at any time dampened by rain, they used to be dried under shade. The annual ritual also involved applying either a paste of coconut leaf juice (*Coccinia Indica*) or wood charcoal or with turmeric (*Cucuma longa*). This is to make the palm-leaves to be insect proof. Some times the palm-leaf manuscripts were kept in the rays of the rising sun or the setting sun possibly for destroying the traces of the growth of insects and microorganisms. When stored along with the bundles of the manuscript pieces of *vasambu* (*Acorus calamus*) or dried ginger (*Zingiber officinale*) was also kept with the manuscripts to protect them from insects. Neem leaves (*Azadirachta Indica*) were also kept with the manuscripts to protect them against insects and such neem leaves are to be renewed whenever required. I have seen palm-leaf manuscript bundles were applied with turmeric powder to protect them from insects and fungi.

Traditional keeping of the palm-leaf manuscripts in the kitchen lofts made them free from the fungi and insects. More over herbal insect repellents such as sweet fig i.e. *ghora* bark (*Acorus calamus*) was also used to prevent the insect attack.

Colours have effect on insects. In the ancient times in order to avoid the insects, the documents were kept covered in red cotton cloth. Turmeric powder (*Curcuma longa – Haldi* (Hindi), *Manjal* (Tamil), *Harasina pudi* (Kannada)) was also used to keep them from insects and fungi. Dry neem leaves, neem seed powder, tobacco, cus-cus, camphor, citronella oil etc., were used to preserve the archival materials. Neem (*Melia azadirachta*) consists mainly *nimbin* and *nimbiol.* These two chemicals present in the neem leaves are good repellents of various kinds of insects. *Adathoda* (*Adathoda zelyamica*), tobacco

(*Nicotiana tobaccum*) and *thulasi* (*Ocimum bacillus*) were also used to preserve paper materials from the insects and fungi. Even today, Thanjavur Maharaja Serfoji's's Sarasvati Mahal Library continues to adopt an ancient method of prevention using herbal materials. The recipe is as follows:

Sweet fig (*Acorus calamus*)	1 part
Black cumin (*Nigella sativa*), *Sombu* (Tamil), *Jeerike* (Kannada), *Kala jeera* (Hindi)	1 part
Bark of cinnamom (*Cinnamom zeylancium*) ,*Pattai* (Tamil), *Lavainigapattai* (Kannada), *Dalchini* (Hindi)	1 part
Pepper (*Piper nigrum*), *Milagu* (Tamil), *Menasu* (Kannada), *Kali mirchi* (Hindi)	¼ part
Cloves (*Eugenia caryophyllus*), *Kirambu* (Tamil), *Lavanga* (Kannada), *Lavang* (Hindi)	¼ part
Camphor, *Karpooram* (Tamil, Kannada, Malayalam), *Karpoor* (Hindi)	a little

The powdered materials are kept in cloth-sachets with bundles of archival materials and books. . The archival materials and manuscripts etc., are saved in this condition at least for six months. If the records are kept over neem leaf beds, which are dried under shade, they are safe. Book worms are controlled by *sombu* (*Umbelliferae*) powder. The powder made out of cinchona bark is used to protect cloth from insects. It was a common practice to smoke rooms to eradicate insects and fungi with some chemical fumigants.

Turmeric (*Curcuma longa Linn*) is a perennial herb of the ginger family. It has been used in culinary use, as a dye, as an indicator, as medicine and also in the preservation of manuscripts. Turmeric powder was used to apply over the palm-leaf manuscripts to avoid both fungal and insect attacks. Turmeric powder was also used in the preservation of paper manuscripts. This is a practice both in the north and south India alike.

The writing materials are soaked in cow urine for 5 to 6 hours in order that the materials absorb urine and do not allow the insects and worms. The manuscripts will not be brittle if this method is adpoted.

Plant leaves had been extensively used by the ancient to protect the manuscripts from ageing. All the plants were not used. Only a very few plants and their parts had been used and still they are used. They are the following:

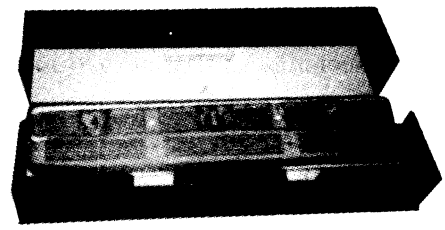
- Neem – *Azadirachta indica*
- Adathoda- *Adathoda zeylanica*
- Chrysanthemum-*Chrysanthemum cinerarifolium*
- Tobacco- *Nicotiana tobaccum*
- Thulasi- *Ocimum bacillum*
- *Karinjottei-Samadera indica*
- *Sotrukathazhai – Aloe vera*

Use of dry neem leaves, *thulasi* leaves, tobacco leaves, oxalis leaves, marigold flower petals etc., was in vogue in the preservation of palm-leaf manuscripts in Manipur.

Parts of animals such as peacock feather, snake's slough, silk etc., are used in the preservation of manuscripts.

Storage

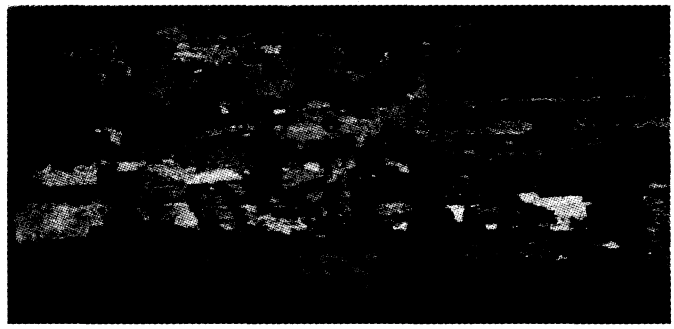
In order to safeguard the palm-leaf manuscripts, they used two seasoned wooden boards generally of sal (*Shorea robusta*), teak (*Tectona grandis*), jack fruit (*Artocarpus integrifolia*), neem (*Azadirachta indica*) etc. The most effective conventional practice of protecting manuscripts was wrapping the manuscripts in red, yellow and sometimes in white cotton cloth occasionally in silk cloth. Traditionally palm-leaf manuscripts were preserved in the loft of the kitchen, probably to drive away the insects and fungi from palm-leaf manuscripts. These bundles were used to be taken out of the storage on the *Vijayadasami* day, cleaned and kept back. I have been told by many in the villages during my collection tours that by throwing the manuscripts into rivers, wells or tanks lost many thousands of palm-leaf bundles. The manuscripts were kept in the early morning or evening sun.



Storage Box

Normally palm-leaf manuscripts were kept in the loft of the kitchen and they were protected from fungi and

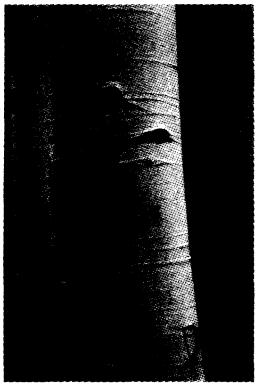
insects. They were also covered with red silk to avoid the insects from attack. The palm-leaf manuscripts were also kept inside wooden boxes and preserved. There are references that the bundles of palm-leaf manuscripts were kept in cradles. The owners knelt before them and worshipped (See picture). Burning of incense and aromatic plants, etc., was in vogue in the olden days and is still in practice, which is to protect the manuscripts from pests and fungi.



Storage of Manuscripts Depicted on Illustrated Manuscripts

In order to provide passive climate control to the collection and maintain natural air-conditioned environment buildings were designed accordingly. Suitable places in side the temples were chosen to protect the collection of manuscripts.

RECORDS AND MANUSCRIPTS ON BARKS



Birch Tree

Birch bark was commonly used in the earlier days for writing records. It was bark of birch tree. Birch bark was used in India from early times. The earliest birch bark manuscript known so far belongs to 2nd or 3rd Century A. D. The bhoja trees grow at a height of 14,000 feet in the Himalayas. King Bhoja understood the use of barks of bhoja trees for writing in 17th Century. During the Mughal Emperor, Akbar, the use of paper replaced the use of birch bark and palm-leaves. In India, it was used as *bhoja-patra,* which is supposed to be a very sacred writing material in India. Birch-bark was in extensive use in the northern India especially in Jammu and Kashmir and other hilly areas. Even today, *bhoja-patras* are available in the north Indian houses as the houses in Tamil Nadu have the palm-leaf manuscripts.

Birch-bark Manuscripts

Birch-bark (*Betula* spp.) is composed of several thin layers of sheets as that of a paper. Each layer is naturally adhered by gum as well as knots. When separated, it will be like tissue paper. It is brown in colour. Organic solvents will be able to dissolve the gum. The bark contains about 40% of cellulose. Salts of salicylic acid are also present. It contains about 10% of lignin, which is an unwanted compound as far as the preservation or birch-bark is concerned.

Birch-Bark Manuscripts

Preparation of Birch-bark Manuscripts

The peeled of bark was dried and applied with oil and polished so that it is suitable for writing. The inner portion of the bark is used for writing. It is cut into shape, holes were made in the centre to run the cords to hold the leaves together and tied after protecting them between two wooden covers like that of palm-leaf bundles. The ink used for writing on the birch-bark was carbon ink. Writings were done with pen and ink. In case of scratching the letters with sharp writing tools thick barks were used as such.

Deterioration of Birch-bark Manuscripts

Birch-bark is multi-layered. Because of the high humidity adhesive property of the natural gum, which binds the layers the birch-bark disintegrates. Because of low humidity, the flexibility of the birch-bark is lost. Due to age, the birch-bark becomes stiff and brittle. Excessive moisture makes the sheets stick to each other. The separation of the stuck sheets will be very difficult. Due to the presence of the insect repellent natural compounds in the birch-bark, like salicylic acid, even at high humidity insects and fungi do not grow.

Conservation of Birch-bark Manuscripts

Since organic solvents will dissolve the natural gum present in the birch-bark, only water should be sparingly used to remove dirt and other stains very carefully with out affecting the writings. It becomes very brittle in the dry condition. But it can be relaxed by moisture without affecting the writings. A tightly wrapped wad of writings on birch bark was found inside a Buddhist image of the 18th Century. It was possible to unwrap it, and to recover eleven legible documents from the wad. Majumdar was successful in separating the blocked birch bark leaves by the exposure of the leaves to steam. Even though the layers are completely separated no attempt should be made to separate them. In such cases the separated layers may be fixed together with tamarind paste. The separated edges can be treated with paste with the help of a fine hairbrush. The damaged edges may be repaired with the help of paper. If the birch-bark manuscript is totally disintegrated, then it should be reinforced with transparent cellulose acetate foil. But this cannot be an ideal way as the cellulose acetate foil binds only the outer layer. Encapsulation can be done. Since the edges are very easily damaged it is always better to cover the birch-bark manuscripts with the help of two planks larger in size than the manuscripts. In order to avoid frequent handling of these manuscripts, they may be kept in almyrahs, which are airtight where insect repellents and fungal repellents can be kept to avoid insects and fungi.

Conservation of *Sancipat*

Sancipat, pronounced as *bancipat* is the name of a tree commonly known in Assam as *agaru* tree, and *pat* means the sheet as the support material for *manuscripts*. The *pat* is prepared from the bark of the tree. Based on the literary account available in *Harsacharita*, written by Bana, it may be presumed that manuscripts were written on *sancipat* in Assam as early as the seventh century A.D. However no collections of this period have so far been recovered or reported from any part of the country. On the basis of the collections of *sancipat* manuscripts available in India, the antiquity of its use as writing materials goes

Sancipat Tree

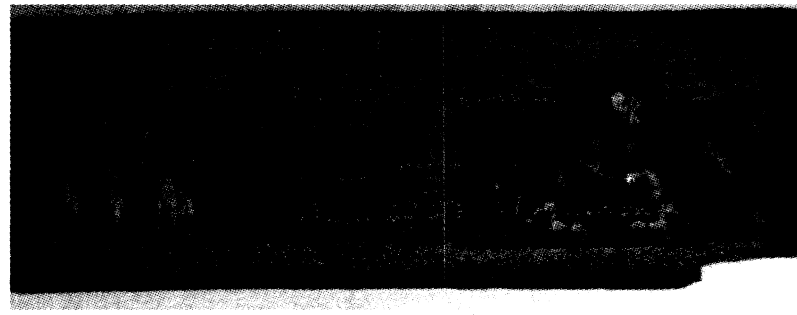
back to 15-16 A.D. A *tantric* work, Arya Manjusrikalpa, also mentions the use of agro-valkal, which means, bark of *agaru* tree.

The *Agaru* Tree and its Uses

Agaru tree belongs to the family of *Thymelaeuceac*. Its botanical name is *Aquilaria malacensis Lamk*. It is known as *Aggalicandanam* in Tamil, *agru* in Telugu, *agar* in Hindi, *agaru* in Assamese. It grows well in hilly areas. Once the tree is 15-20 years old, it tends to get infected with fungi and from the fungal infected area oil is oozed out, which is used as perfumery and medicine. Aloes woods (*Aquilaria agallocha*) is also chosen for the preparation of *sancipat* leaves.

Preparation of *Sancipat*

The bark of the *agaru* tree cannot be used for writing. Traditionally, the barks are subjected to a particular processing indigenous to Assam for centuries. The bark of about 30-35 inches of breadth is selected from a live tree and stripped off. These strips are rolled up separately with the inner white part of the bark outwards, and the outer green part inside, dried in the sun light for some days until dried up well and cut into pieces of convenient sizes, normally 9 to 27 inches long and three to eighteen inches broad or of any other size as needed. These pieces are then immersed in water at least for three days and dried under sunlight. Then the barks are soaked in water to remove the alkali and kill the insects and worms if any. The outer green layer is removed carefully and the surface is scraped smooth with a knife and dried under sun for half an hour and rubbed with burnt brick. A paste prepared from *matimah* (*Phascolus radiatus*) is then rubbed in. The smooth bark is then dyed yellow by means of arsenic sulphide and also by vermillion. The dyed bark is dried in the sun. The bark strips are rubbed again as smooth as marble. The centre of each leaf is perforated for inserting the chord for fastening. The strips are ready for use as a sheet to be written upon with a specific Assamese ink.

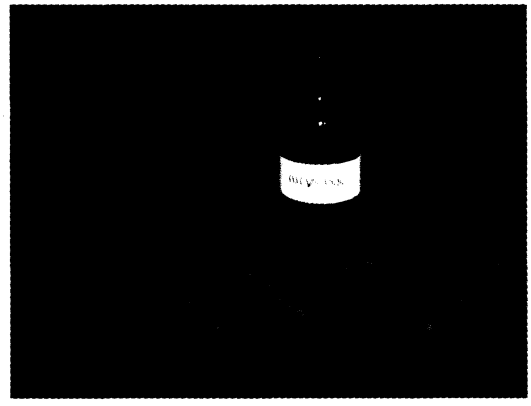


Sancipat Manuscript

Ink for Writing the *Sancipat*

The basic ingredients of the ink for the *Sancipat* are *kehraj* plant (*Verbesina prostrate*), unriped green *silikha* or *haritaki* (*Terminalia citrina*), urine of cow, a piece of rusted iron heated in fire, a phosphorent extract from large earthworms, dew drops and the ash of cooking iron pot.

The *kehraj* plant is plucked out, washed and the extract is collected by crushing and kept in an earthen pot. The juice of the green *silikha* is also mixed with the juice of *kehraj*. Equal quantity of the urine of cow is taken and mixed with the above mixture of juices. This solution is heated till it becomes thicker or denser. A piece of iron is heated red-hot and plunged into the thus prepared mixture and by this the mixture takes a dark colour. Thus obtained solution is filtered off the unwanted solid matter. Large sized earthen worms are taken and a little salt is sprinkled on them and the liquid seeped out is mixed with the prepared solution in equal volume. Thus prepared ink is diluted by adding dew drops. The ink is stored in an ink-pot made of bamboo.



Pens & Ink

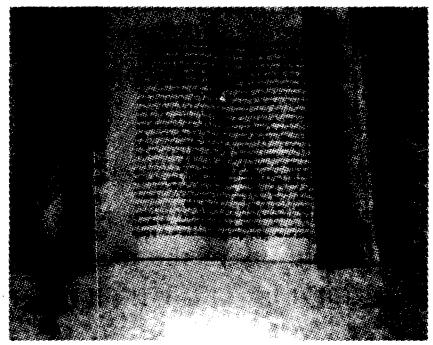
Writing Instrument

Writing pens are made out of a fern called *dhekiya* or reed and is very smooth to write *sancipat*. In order to prevent the nib from becoming blunt, the bottom of the pot is filled with hair. Goose quill is also used. There are references that pens have been made out of bamboo with sharpened portion as nib.

Indigenous Conservation Methods

The process of making *sancipat* itself has the elements of preventive conservation. The destructive elements are removed from the *sancipat* during its very preparation. Manuscripts are normally wrapped with red cloth or white cloth dyed with turmeric-juice. They are some times stored in the loft of the kitchen. Tobacco is rubbed at the edges. Neem leaves are also placed along with the manuscripts. Sometimes the *sancipat* bundles are kept in wooden boxes. With the help of all these indigenous methods of conservation, manuscripts dating as far back as the fifteenth Century have been preserved in different repositories in Assam.

RECORDS AND MANUSCRIPTS ON PARCHMENT



Parchment Manuscripts

Parchment is the processed lower part of skin of animal, especially of the sheep, calf, and goat, prepared for use as a writing material. The name is a corruption of Pergamum, the ancient city of Asia Minor where preparation of parchment suitable for use on both sides was achieved in the 2nd Century B.C. Parchment and leather were used in the ancient times especially in the mediaeval Europe and Western Asia for writing purposes. It superseded the use of papyrus. The famous Ur excavation revealed bundles of parchment records and they were released out of folding and the details were deciphered. In museums and archives the leather-based manuscripts are available either in the form of illustrated manuscripts or records.

Processing of Leather

Leather is nothing but cured skin, which is de-haired, defatted, and made non-putrient and impervious to water. Skin is a net work of protein fibres chiefly collagen. Unless cured, moulds and bacteria destroy the raw skin. Tanning is a method of finishing skins to produce leather. Tanning can be done traditionally by using the essence from the barks of certain trees or by minerals like salts of chromium, which render leather impervious to water while preserving its flexibility. Semi-tanned leather is produced by stretching the skin from which flesh etc., have been removed and then rubbing on it with oil or a fat emulsion. The skin becomes soft and flexible by this and then it is smoked. Semi tanned leather is used to make costumes, pouches, headgears etc.

The parchment is nothing but the flesh side of the skin, which is processed. Parchment is made out of the skins of small animals such as sheep, goat, antelope, deer, etc. The parchment prepared out of the skin of calf is called vellum. The split skin or the parchment is stretched on a frame and scraped down with a crescent shaped knife on both the sides. When it is being dried the skin is tightened and scraping is continued. The parchment is treated with hot water, scraped again and while still wet, rubbed with pumice stone on both the sides. The parchment is dried on the stretched frame. Parchment is translucent and is used in puppetry and for writing purposes. In order to use the parchment for writing purposes it should be bleached and the grease should be removed by lime wash. The flesh side is preferred for writing. The transparency may be obtained by chemical treatment.

Deterioration of Leather

Museums have many leather based manuscripts in their possession. Parchment records and manuscripts are also preserved in the museums. Archives have large volumes of books, which are leather bound. Since the leather-based manuscripts are organic in nature, they very easily deteriorated. High humidity affects leather based materials as the moisture increases the water content of the leather and facilitates the growth of micro organisms such as insects, pests, fungi. As parchment is hygroscopic in nature it gives off moisture and becomes dry at dry climates.

Brittleness or *hardening* is another defect in these types of materials. When parchment loses its water content or in other words when the leather is dehydrated it gets hardened and distorts in shape. Slight mechanical stress will make it to break.

Dust accumulation creates a lot of problems by becoming dirt, which not only obscures the details on it but also sulphur, carbon and nitrogen dissolve in the moisture present in the atmosphere and increase the acidity in leather and parchment.

Parchment comprises of fibrous protein called *collagen*. Collagen is a polymer of different amino acids. Collagen breaks down into smaller units by hydrolysis to give gelatin and the conversion is rapid at higher temperature and relative humidity and the pH is greater than 6.5. Parchment is alkaline and there fore it becomes yellowish. It is hygroscopic in nature and therefore gets hydrolysed in excess of moisture. As it dries the skin tightens considerably and the deformation of the membrane results in the loss of ground as well as writing ink. Being organic in nature, parchment manuscripts are attacked by fungi and insects.

Conservation Measures

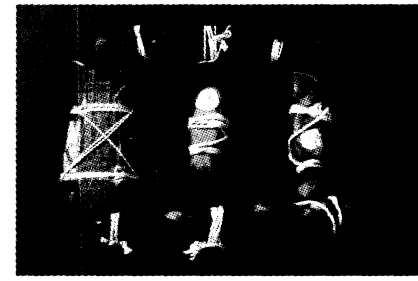
As leather and parchment are organic in nature, it is always better to maintain the relative humidity and temperature at optimum levels (50±5%) . In order to protect them from insects, fungicides such as chloro nitrophenol and insecticides such as chloro-pyriphos may be used.

Hardened leather based materials should be made flexible by the application of leather dressing materials. The parchment should be applied with 2% castor oil in rectified spirit and rubbed. The excess of castor oil may be removed by rectified spirit. In case the letters are soluble in rectified spirit, proper solvent for the castor oil such as acetone, methanol should be chosen. Distortion should be removed by the application of 5% water in rectified spirit and the area is flattened and then treated for flexibility by 2% castor oil in rectified spirit.

RECORDS AND MANUSCRIPTS ON PALM-LEAVES

Man in the past has chosen palm-leaf as one of the materials for writing and keeping records. The use of palm-leaves was in vogue in almost all South and Southeast Asian countries. Even though the use of palm-leaves is very old, the use of palm-leaves came into practice some time in 6th Century B.C. The earliest availability of palm-leaf manuscripts in Nepal was from 7th Century A.D. Palm trees are in plenty in Indian sub-continent and in Southeast Asia. It has been mentioned that palmyra tree was brought to India from Africa. Roughly 4000 species of palm trees exist all over the world. Among them two varieties were chosen to write. They are the palmyra palm (Borassus flabellifera Linn) which is called as *tala* and fan palm (*Corypha umbracufera Linn*) which is otherwise called as ***sritala*** or *tali* pot. The palmyra grows to a height of 15 to 20 metres. The leaves are thick and coarse and are suitable for incision with a stylus. The talipot palm is taller and grows up to a height of 20 to 25 metres. The leaves are thin and flexible and light coloured. In this case writing is done with carbon ink. The palm-leaves used for writing are about 40 cm to about 1 metre long and 5 cm to 8 cm wide. The bundle thickness sometimes will be around 50 cms. There are different types of styluses and shapes of bundles of manuscripts.

Styluses



Shapes of Manuscripts

Preparation of Palm-leaf Manuscripts

There are various methods of preparation of the palm-leaf manuscripts in different parts of the world. The tender leaves of 4 to 5 weeks old are cut and dried under shade for a week and buried under marshy water for about 3 months and cut into size and used for writing. The other method is to boil the dried leaves in turmeric solution and cut into required size. In the case of *tala* the writing is done with the stylus. The incised portions were filled with lampblack mixed with gingely oil. In some other places the incised portions were rubbed with the leaves of ***kadukkai*** plant (*Terminalia chebula*) or green leaves of ***kovakkai*** plant (*Coccinea grandis*). The incised portions after some time get black colour making the letters

legible. In case of the *sritala* leaves only writing is done with ink or paint. After the writing is done, the palm-leaves are kept in position by punching two holes at both sides of the leaves. A red coloured linen or cotton cord then passes through the leaves. Two planks are kept on both the sides and the planks are tied with the help of the cord. If the leaves are more than 100, then a needle like bamboo stick/wood *narasam* is inserted along the holes to hold the leaves safely. The planks are sometimes painted. Cotton cloth dipped in turmeric solution and dried is used to cover the bundle. The bundles are kept together and are covered with a red cloth. The red cloth is a good repellent for the insects. Covering the palm-leaves protects the palm-leaves from dust and it provides a microclimate with in the bundle.

The Physical and Chemical Characteristics of Palm-leaves

The durability of the palm-leaf manuscripts depends on the physical and chemical characteristics. The leaves of the *tala* variety are coarse and thick and therefore liable for brittleness than the *sritala* variety. Chemically speaking, the palm-leaves are made up of cellulose, resins, oils and ingredients like lignin. Even though the cellulose fibres are very strong, they can be broken up by the action of oxygen and ultra violet radiation from sunlight. If the oil content of the palm-leaves is lost, the palm-leaves become brittle. The palm-leaves being organic in nature insects attack them very easily.

Causes of Deterioration

Palm-leaves are organic in nature and therefore they are vulnerable to biological deterioration. An unfavourable environment will be unfavourable for the upkeep of the palm-leaf manuscripts. In order to save the palm-leaves, one must know the various deteriorating factors or aggressions. They are mainly affected by natural and man-made agencies.

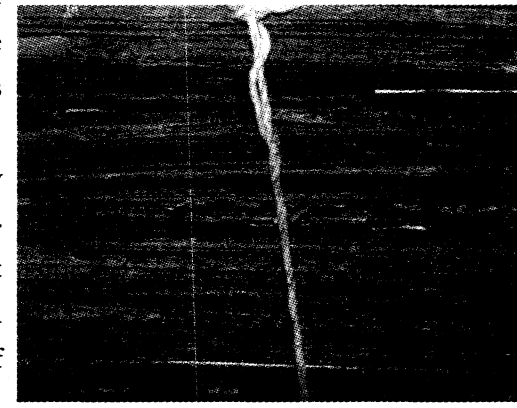
Atmospheric Factors

Atmosphere is one of the agencies, which contains most of the deteriorating elements. The various acidic oxides present in the atmosphere are absorbed by the palm-leaves when required moisture is available in the palm-leaf manuscripts and there by the acidity of the palm-leaves are increased. The intrinsic factor of the palm-leaf, manuscripts is also responsible for the increase in their acidity. Oxygen of the atmosphere breaks the cellulose of the palm-leaves and they become brittle.

The moisture in the atmosphere increases the moisture content of the palm-eaves and chemical change takes place with in the palm-leaf manuscripts. It is always better to maintain the relative humidity at 45 to 55%. The temperature is yet another factor, which affects the palm-leaves. The ideal temperature for the good upkeep of the palm-leaves is 19±1°C. If moisture is more, then the palm-leaves will be stuck together.

Biological Factors

In the damp condition, biological agents like insects and fungi flourish very well and damage the manuscripts. Some of the insects tunnel through the bundles by eating the leaves. Some groups of termites cause very great damage to the palm-leaf manuscripts if favourable climate is present. Fungi grow very well on palm-leaves when condition suitable for their growth exists. They eat away palm-leaves and damage them very seriously. Because of the tunneling of the palm-leaves by insects, the leaves stuck together and it is very difficult to separate them. Bookworm (*Gastrallus Indicus*) is the dangerous enemy of palm-leaf manuscripts.



Stuck Leaves

Physical Damages

Palm-leaf manuscripts become dry if they are not cared for a long time. They wrinkle, and the edges get damaged and crumble at the edges. Careless physical handling also damages the palm-leaves. Improper storage creates a lot of problems to the palm-leaf manuscripts and their deterioration is faster. Even neglect will make them unusable.

Stains and Change of Colour

Due to aging, the palm-leaf manuscripts get brown colour. Constant use also makes them to take up brown colour. Due to the accumulation of dust and the action of fungi on the edges they appear black in colour. Stains are formed quite often due to the excreta of flies and mosquitoes. This will be visible as small black dots. Dead insects also sometimes develop stain on the manuscripts when the leaves hold the dead insects in between. Unless removed, these stains will be embedded into the leaves.

Dust

Dust is yet another danger to the palm-leaf manuscripts. Prolonged neglect and poor storage would result in the accumulation of dust on manuscripts. If the dust is not removed it will become dirt in the presence of moisture and will become the food for the microorganisms. The dirt will make the palm-leaves unreadable.

Defacing of the Writings

Due to the constant use or due the biological activity the palm-leaves loose the clarity of the writing and are not readable. The carbon paste used normally gets detached from the leaves and falls down in due course and the writings are not readable.

Deterioration of Palm-leaf Manuscripts

Manuscripts deteriorate by various means. They are,

- Eaten by insects such as termites, silver fish, book lice.
- Stuck due to insect attack, oils, varnish.
- Warping of leaves takes place if the palm-leaves were not kept tightly between wooden boards and due to uncontrolled drying in the sunlight.
- Edges get broken due to insect attack, mishandling by users and when wooden boards are smaller than the manuscripts.
- Brittle leaves break when the atmosphere becomes very dry and the leaves lose their moisture.
- Stains and pen marks are formed when the users and the custodians become careless.
- Leaves get damaged at cord holes because of constant uncontrolled movement of the leaves.
- Fire can destroy thousands of manuscripts in a few hours.
- Flaking of paint occurs due to rubbing of the palm-leaves against each other when they are loosely bound.

Damage Due to Improper Air-conditioning

If air conditioning in the area where manuscripts are stored is switched on and off, then the fluctuating temperature and relative humidity cause expansion and contraction of the manuscripts causing them to weaken and break. Fungus grows in high humidity. Leaves tear horizontally.

Damages Due to Human Factors

Theft, vandalism, improper storage, mishandling while using, transportation, carelessness in the part of staff and users etc., lead to a loss of palm-leaf manuscripts.

Protection of Palm-leaf Manuscripts

- When one receives or acquires a manuscript, it should not be kept immediately with other manuscripts, because if it is infected by fungi and insects, it will pass on the infection to the unaffected manuscripts. It may be cleaned by brushing it gently and removing any insect larvae that may be noticed and fumigated with thymol (fungi) and para dichloro benzene (insects)
- Wood powder falling out of holes in wooden boards indicates insect attack. The boards should be replaced and specialist treatment should be sought.
- Palm-leaves should not be tied in the centre only, but it should be through out.
- Keep leaves tightly pressed between boards by tying with a cord to apply even pressure.
- Store the manuscript bundles neatly, if possible in closed racks, boxes or cupboards.
- Wrap the manuscript in a thick cotton cloth, preferably red cloth.
- Keep important and rare manuscripts in small strong boxes which should be the first to be removed to a predetermined safe place in case of an emergency or disaster.
- Handle the leaves gently when turning them over.
- Do not mark or underline with pen on the original leaf.
- People in-charge of collections must document and publish the contents of the manuscripts. Instead of the original manuscript, copies or microfilms or CDs should be made available to scholars for reference. Condition reports should be prepared.
- Most of the damage takes place in storage. Regular inspection is a must and any damage should be immediately reported to the concerned authority who must take action to preserve the collection and its contents.
- Responsibility should be placed on someone to look after the manuscripts.

Protection of Manuscripts from Dust and Atmospheric Pollution

- Dust and atmospheric pollution should first of all be eliminated by not having the collection in a dusty or polluted area.
- The building should be made dust free by planting grass and trees.
- Important collections should be in the inner rooms.
- The windows should be closed when ever possible.

- An air curtain could be provided at the entrance.
- A series of door mats should be placed along the way to the collection room. These mats should be cleaned regularly.
- Manuscripts should be kept in closed showcases of boxes.
- A distance should be maintained between the visitor and the manuscript.
- Room furniture should be cleaned with a damp cloth or vacuum cleaner.
- Do not clean the manuscripts with a vacuum cleaner if they are fragile.
- Sweep the floors only with vacuum cleaners. If there is no vacuum cleaner, then sweep slowly with broom hugging the ground.
- The air intake in AC plants should be high up and should be in the least polluted side of the building e.g. the side not facing the traffic. For eliminating sulphur dioxide and dust, fine water sprays can be used to wash the air before it is brought into the air conditioning system.
- The manuscripts should be covered when not being used or viewed.

Protecting Manuscripts from Light

- Light bulbs inside closed showcases heat and dry up the air causing the manuscripts to become brittle and break easily.
- Manuscripts should be displayed at a light intensity of not more than 50 lux. The lux meter should be placed parallel to the displayed manuscript.
- If light intensity is higher than 50 lux, bring it down to 40 lux by switching off extra lights or by dimming them using a dimmer switch. Light intensity can also be decreased by increasing the distance between the light source and the manuscripts on display.
- Sunlight and tube light weakens the manuscripts because the ultraviolet rays in them damage the leaves.Block sunlight by closing windows or by putting curtains on windows or over manuscripts.
- Ultraviolet filters can be put over window panes and tube lights to cut off these harmful rays.
- Zinc oxide or titanium oxide, which absorbs UV rays, should be used to paint the walls and ceilings and the light from fluorescent tubes can be reflected off them.
- The manuscripts should be covered when they are not viewed by the visitors.
- Lights should be switched off when there are no visitors seeing the manuscripts, or the manuscripts can be covered.

Protection of Manuscripts from Insects

- Healthy manuscripts should be kept in closed boxes or cupboards.
- Natural insect repellents such as dry *neem* leaves can be placed along with the manuscripts.
- Insects in the larva stage eat away the manuscripts. Newly acquired manuscripts may contain insect eggs and larvae which will infect the healthy collections. Therefore the infected manuscripts or newly acquired manuscripts should not be kept with the healthy manuscripts collection.
- The insect eaten wooden covers of manuscripts should be replaced with new ones.
- Food should not be brought near the collection storage and gallery to avoid pest attack.
- The cloth to be used to cover should be made acid free and starch free and this should be effected by thorough washing.
- Regular inspection of the gallery and storage of the manuscripts should be made and if powder formation is noticed, it should be immediately reported to the authorities for rectification.
- The infested manuscripts should be removed from the collection and treated separately.
- If a fumigation chamber is available with appropriate chemicals the insect infestation may be removed with the help of a trained staff. If nitrogen fumigation is done, then it is not injurious to both men and the manuscripts.
- The windows should be closed during nights. In order to avoid insects and avoid other vandalism, a mesh or net may be fixed to the windows.
- The premises should be kept clean.
- If a new building is to be constructed for storing or displaying manuscripts, it should be treated for anti-termite attack. Old buildings should be treated for termites once a year. The building should be used only after three months.
- The collection cupboards should be away from the walls and the contact points such as the legs of the cupboards should be treated with insecticides.

Protection from Temperature and Relative Humidity

- Temperature and relative humidity should be constant as much as possible by keeping the manuscripts wrapped in de-starched cotton cloth in an inner room and moisture absorbing materials such as cotton curtains, wooden furniture etc., should be around the collections. These buffer materials absorb and release moisture slowly thus decreasing the harmful effects of fluctuations.
- If air-conditioners are used, it should be 24 hours and 365 days a year. It is better to have been undisturbed rather than air-conditioning only during office hours.
- If manuscripts have paintings on them, the leaves should be intervened with tissue paper to avoid abrasion and also to act as a buffer.
- The temperature and relative humidity should be recorded for future assessment purposes so that corrective steps may be taken at the appropriate times in the future.
- Movement of visitors should be regulated. Too much crowd may not be allowed at a time.
- No pipe lines, wash basin, toilets or water accumulation should be allowed.
- Silica gel with self indicator may be used to control relative humidity. Silica gel appears pink when absobs moisture. The silica gel should be heated to regain blue colour, and again kept in the storage. Fluctuations in the relative humidity will break or make the manuscripts got wrinkled.
- There should be air circulation to avoid fungal growth in the collection.
- Exhaust fans may be used to exhaust damp air from the room.
- Wet manuscripts should never be dried under sun but under shade.

Preventive Measures

Prevention is better than cure. Strategies of the preventive conservation should be taken into account. The type of the collection should be known very well for those who are in charge of the collection. The enemies must be identified and categorised. In the case of entry of the enemies, they should be avoided by providing suitable environment. Even after providing suitable environment for the cultural property, if there is defect, the enemy may be blocked from attack. They should be regularly checked and monitored. When the enemies of archival materials or maruscripts are entering into the records, one should react immediately to get rid off them. The message should be communicated to all the concerned and suitable conservation measures should be taken.

Physical Examination of Manuscripts

What ever may be the condition of the palm-leaves, it is very essential to examine the condition of the palm-leaves to give suitable conservation treatment. The number of manuscript leaves in a bundle should be noted down. The condition of the manuscript should be recorded to proceed further. The dimensions, previous treatment given, the provenance, reference to the photographs taken, previous publication, proposed treatment etc., should be recorded.

Conservation of Palm-leaf Manuscripts

We can not generalize the type of treatment to all the palm-leaf manuscripts as the treatment differs from one to the other depending upon the condition of the manuscripts and defects found in them. The strategy towards the conservation is very important. Like preventive conservation, conservation of the manuscripts is also very urgent one. Some times only one treatment may be necessary. In some other cases many measures are to be taken. The restoration is not so urgent. The conservation of the manuscripts is urgent and it depends only on the condition of the manuscripts.

Cleaning

Cleaning of palm-leaf manuscripts is an important prerequisite for all subsequent procedures of treatment to be exercised. Cleaning should be done before any chemical treatment. Otherwise the dust and dirt will create problems in the conservation procedure. The physical cleaning can be done with a squirrel hair brush to remove the loose dust and adherent solid materials. The dirt, which is hard to remove by brushing, should be removed by moistened cotton swab. This can also be done away with a dampened cloth. If it is difficult to remove, then along with water a little soap solution may be added. If the condition of the palm-leaf manuscript is good, then the manuscripts may be dipped in water and all dirt and dust may be removed. In case they are weak, then organic solvents such as acetone, benzene, rectified spirit should be used to remove the dirt and other excreta of the insects and fungal deposits. Whenever water is used, it should be seen that the water should be dried carefully to avoid wrinkling of the manuscripts. Glycerin in water (1: 10) is used to remove the dirt. If they are found weak, glycerin in rectified spirit may be used. Some times there will be a deposition of soot on manuscripts. It should be removed with the help of rectified spirit. If the manuscript is painted care should be taken when solvents are used.

Before using the solvent, it should be tested in an inconspicuous comer for the fastness of the pigment. Organic solvents such as ethanol (rectified spirit), acetone, carbon tetra chloride, methanol, methylated spirit, toluene, petroleum ether, benzene, pyridine, tri chloro methane may be used. Hydrogen peroxide is also used in case the stains are persisting.

De-acidification

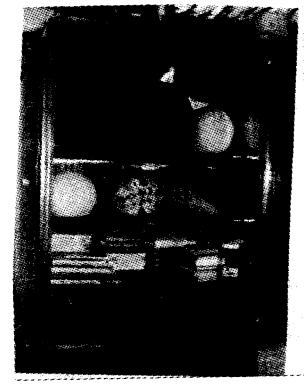
Some times the palm-leaves are brownish in colour masking the details. In such cases it is better to remove the brown colour to have a better look and legibility to read. Unless the acidity from the palm-leaves is removed, the palm-leaves will become brittle. Before any attempt is made for the de-acidification, the leaves should be numbered. In case the leaf is broken all the broken pieces should be given the same number: The palm-leaf manuscripts may be either dry de-acidified as in the case of paper with ammonia or wet de-acidified. For wet de-acidification of manuscripts written with water-resistant inks, use of calcium and magnesium bicarbonate solution is encouraging. Both dipping and spraying can be done. A 5-10% solution of glycerin will be useful in this process as it adds strength to the palm-leaves while washing. When palm-leaves are containing water soluble inks, barium hydroxide in organic solvents such as acetone, methanol, ethanol, or magnesium hydroxide in methanol or magnesium acetate in ethanol may be used to remove the acidity. This may be done either by spraying or dipping.

Fumigation

Fumigation is a very important activity in archives, libraries or museums where palm-leaves are preserved. It is better to fumigate palm-leaves when they are entering into the archives or museums. Since palm-leaves are organic in nature, microorganisms very easily affect them. It is therefore good to fumigate them before any conservation treatment is provided. There are various chemicals used to fumigate the palm-leaf manuscripts depending upon the type of insects or fungi. An airtight fumigation chamber with perforated shelves and glass fitted doors and an arrangement in the centre of the bottom most plank for heating chemicals like thymol crystals with the help of a 40-watts incandescent bulb could be used equally for fumigating manuscripts against insects and fungi as in the case of paper

Fumigation Chamber

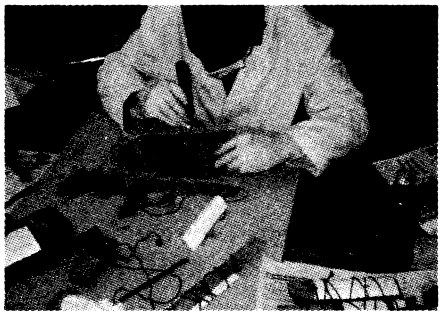
manuscripts. Para di chloro benzene is a very good insect repellent. A mixture of carbon tetra chloride and trichloro ethane is effective against the insects. This mixture should be kept on the top shelf of the fumigation chamber, as the moisture is heavier than air Naphthalene bricks may be kept in the racks. It is better to fumigate palm-leaves periodically to avoid both insects and fungi.



Nitrogen Fumigation Chamber

Separation of Stuck Leaves

Palm-leaf manuscripts at times are found stuck together. This is called blocking of manuscripts. There are many reasons for this. The palm-leaves might have been wet due to rain or due to very high humidity. Some times this happens due to the worms tunneling the bundles. It is very difficult to separate the leaves in such cases. It is better to get training in the preservation of palm-leaf manuscripts and start doing the job or it may be entrusted to a skilled conservator. Anyhow, in such cases, it is better to consult a conservator. If the stuck or blocked manuscripts are kept in a humidifier in a relative humidity of around 85-90%, the leaves get softened and they can be separated using a scalpel or paper cutter very carefully and patiently. Exposing the manuscripts to steam for moistening and loosening the leaves can also do this. No effort should be made to dip the manuscript in water. In case there is no alternative the bundle may be dipped in hot water containing 5-10% of glycerin (5-10 c.c. of glycerin in 95-90 c.c. of water). The separated leaves should be dried between blotting papers. Only after the separation of leaves they should be subjected to cleaning etc.



Separation of Stuck Leaves

Relaxing Flexibility to the Palm-leaves

The major defect of the palm-leaf manuscripts is hardening. The leaves become dry and any act of bending will result in breakage. Therefore the flexibility should be introduced into the leaves by the use of chemicals or natural materials. Many have tried different chemicals

for regaining the flexibility to the palm-leaves. The following are some of the methods of relaxing the palm-leaves:

1. The hardened palm-leaves are cleaned with glycerin and water and then treated with camphor oil, citronella oil, lemon grass oil or walnut oil. This improves the flexibility of the palm-leaves.
2. Hardened palm-leaves are treated with the fresh extract of the green palm-leaves with alcohol. This has been observed that brittle palm-leaves get flexibility when they are treated with a mixture of palm-leaf extract, clove oil, black pepper oil and sandal wood oil.
3. Vegetable oils such as camphor oil, eucalyptus oil, neem oil, citronella oil, lemon grass oil etc., are very effective in softening the embrittled palm-leaf manuscripts. Besides these, polyethylene glycol 200 has been found effective in relaxing the hardened palm-leaf manuscripts.
4. Conservation of paintings on palm-leaves is rather difficult, as the pigment on the palm-leaves is not bound strongly with the palm-leaves. In the case of paintings on palm-leaves many leaves are joined together with the help of tying with thread.

Mending the Broken Palm-leaf Manuscripts

Sometimes the palm-leaf manuscripts are found broken and it is very urgent that the broken pieces should be joined. There are many methods of doing so. The broken edges are cleaned with acetone and pasted with methyl methacrylate or poly vinyl acetate in acetone. Sometimes the joints are repaired with the help of tissue paper and a suitable adhesive like carboxy methyl cellulose. If the portions are missing, similar unwritten palm-leaves are taken and kept below the broken palm-leaf and along the edges of the old leaf a sharp knife is run through so that the new leaf is also cut according to the shape of the broken edge of the old leaf. The new cut leaf is fixed in position and mended with the help of poly vinyl acetate in acetone.

Filling-up the Holes

Insect attacked holes are found on the palm-leaves. Existence of the holes mars the look of the palm-leaf manuscripts. Mulberry tissue paper is ground well with methyl cellulose as a

paste. The affected palm-leaf is placed on a glass plate and the mulberry tissue paper paste is taken in a sharp spatula and the holes are filled with the paste. The repaired leaf is placed in between two tissue papers and kept under a glass plate. If the holes are larger in size, then the unused palm-leaf is cut into shape and applied with an adhesive at the edges and fixed in position. Poly vinyl acetate or methyl methacrylate adhesive may be used in this case.

Re-inking of Palm-leaf Manuscripts

Re-inking the Incised Matter

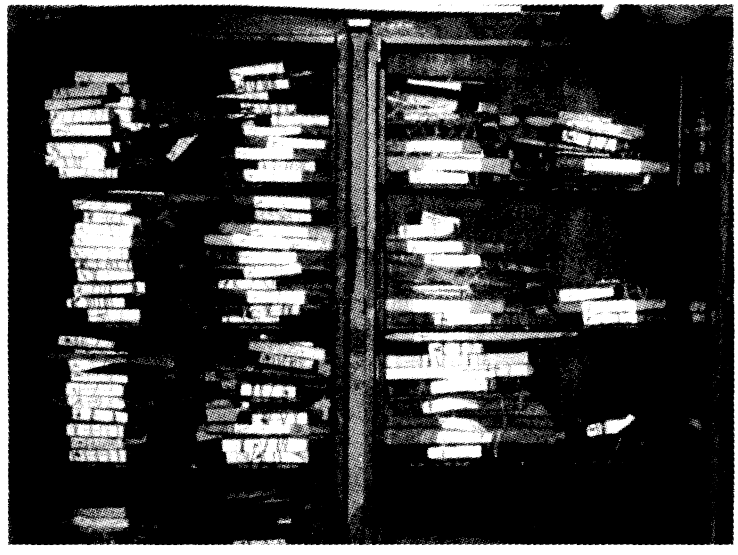
Due to aging the palm-leaf manuscripts loose the writing. In the case of *tala* leaves it is easy to re-ink the letters incised. But in the case of the *sritala* leaves it is difficult to write. In the case of *tala* leaves the incised portions may be re-inked by rubbing with the leaves of the *kovai* plant or by lamp black mixed with citronella oil. Excess lamp black is removed with a cotton cloth and further Cleaning is done either with alcohol or an alcohol-glycerin mixture (1:1). In the Thanjavur Maharaja Serfoji's's Sarasvati Mahal Library, Thanjavur, the palm-leaves are swabbed with a mixture of citronella oil and lamp black in rectified spirit. The excess paste is cleaned with cotton. By this the leaves regain the flexibility and the letters are legible. Citronella oil is very much useful. Some conservators prefer lemon grass oil instead of citronella oil. But the application of lemon grass oil makes the leaves brown.

Reinforcement Techniques

After the palm-leaf manuscripts are mended and the writings are re-inked if the palm-leaf manuscripts are very weak, they should be laminated with tissue paper and carboxy methyl cellulose in order to give reinforcement to the manuscripts. There are various modem methods of lamination. Older methods are also under practice in the archives. Many modem methods of lamination have come into practice in most of the archives and libraries. Lamination techniques are discussed latter in this book.

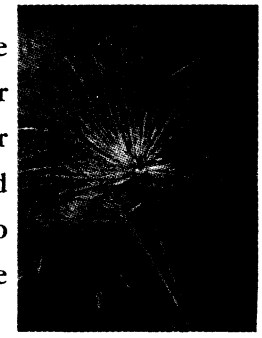
Storage of Manuscripts

1. The palm-leaves may be bundled and wrapped in a red coloured cotton cloth and the bundles may be kept individually in an almyrah with suitable clearance between shelves or shallow drawers of a cupboard.
2. The storage should be so designed that when a particular bundle is retrieved the other bundles should never be disturbed.
3. The rare manuscripts may be kept in side boxes designed for keeping different sized palm-leaf manuscripts.
4. In the case of cartons or bundles there should be provision for writing details of the manuscript, its title, its language, its size, its catalogue number etc.
5. The cupboard or the almyrah, in which the manuscripts are kept, should at least have a clearance of 15 cms from the wall in order to avoid moisture from the wall or floor. Suitable metal or plastic cups, which have provision for keeping insecticides or oil, may be kept under the legs of the almyrah.
6. Insect repellents like naphthalene bricks or para dichloro benzene may be kept along with the bundles. Regular cleaning of the room to get rid off the dust is essential. A vacuum cleaner may be used for removing dust from the room. Periodical dusting of the manuscripts is also desirable. It is better to cover the bundles with plastic covers, which are provided with some holes for the entry of air.



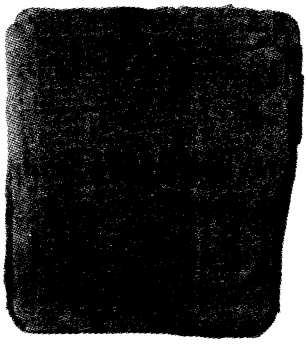
Wrong Method of Storage

RECORDS AND MANUSCRIPTS ON PAPER



Papyrus

Paper is the word derived from a Greek word 'Papyrus'. Papyrus is the name of a plant, which was found on the marshy lands along the river 'Nile' in Egypt. Its botanical name is Cyprus Papyrus Linn. Papyrus for writing purpose was prepared by removing the skin of the plant, arranged in order, pressed and dried under sun. There are references available to prove the use of papyrus is 3500 B.C. Barks were also brought into use around 170 B.C. as a writing base material.



Papyrus Book

Paper was invented by T'sai Lun, a Chinese Public Works Minister in 105 A.D. Mulberry stalk, bark, hemp, rags etc., were made as pulp, mixed with an adhesive, filtered and then made as paper. There is proof for the use of paper in China around 200 B.C. Paper manufacture was later spread to Korea, Japan, Central-eastern countries, and Western countries. In India, paper was manufactured using baggasee, grass and jute and from plants growing in marshy lands. The paper prepared out of baggasee is also called as tree free paper. By this method the trees are not disturbed and the ecology is maintained in the forest. Even though paper is manufactured mainly out of cellulose from trees, tree free paper manufacture is now given importance by the Government paper industries as this avoids the cutting of trees.

The paper prepared out of wood pulp as such cannot be used for writing. In order to make the paper suitable for writing purposes the paper should be glazed by the application of glaze like flour, gelatin, resin, alum etc. In 1798, Nicholas Louis invented the papermaking machine. By this machine paper pulp was sent between two rollers and given the desired thickness to paper followed by sending between two hot rollers, which were suitably heated thereby paper was dried and later rolled in a roller.

Characterisation of Paper

Today paper has got a great role in reflecting the feelings of humanity and bringing news to others. Paper is the main base material of books, newspapers, journals, records etc. In the

beginning, even though rags, grass, hay straw, cane etc., were used to make paper today 90% of the paper is manufactured from wood. Cellulose is the main content of wood up to 60-80%. Wood,which is used to make paper, contains 29% lignin, 43% cellulose, 27% other carbohydrates. Besides these lime, sodium silicate, sulphur, alum, resin, gelatin etc., are used in the manufacture of paper. Wood, which is used for the manufacture of paper, is crushed by machine and made as pulp with the help of chemicals.

Cellulose is required for paper but lignin, tannin, wax etc., present in wood affect paper. Whatever be the method of manufacture of wood pulp, the pulp contains lignin and other dyes. In order to remove the dyes the pulp is bleached with the help of chemical bleaches. Glazing is done to make the paper suitable for writing. The newsprint paper does not contain any glaze. Art paper contains very good glaze to increase the quality of painting.

Paper made out of linen and cotton rags is strong and durable. In this type of paper gelatin glaze is given for writing purposes. The paper made out of wood pulp and glazed using resin and alum for writing purpose is weak and less durable. There are many varieties of paper in between the above two varieties. News print paper is a very poor quality paper, which is less durable. They become very easily acidic and crumble due to aging.

There are some characterizations of handmade paper from the machine-made paper. Handmade paper tears in the same way in all directions, whereas the machine-made paper tears more easily in the machine direction than in the cross direction. Expansion of handmade paper upon wetting is the same in all directions, where as expansion of machine made paper greater in the cross direction than the machine direction. The floating a sheet of paper in water, machine made paper cockles in the machine direction, while handmade paper in all direction. Handmade paper has natural shrinkage while machine made paper has not.

Characteristics of Inks

Ink is nothing but a natural or artificial dye mixed with a liquid to form a liquid, paste or solid compound. At about 2500 B.C., the Egyptians used carbon inks. The Chinese, Romans and Greeks followed it. A fine powder of carbon in oil made the very old carbon ink. It is durable as well as chemically non-reactive. The carbon soot obtained from lamps had been used along with oils in writing, painting and in incised palm-leaves to preserve them. The carbon ink had also been prepared by boiling carbon with resin from trees and water.

The iron gall inks were prepared out of the insects from oak trees or from tannin of some plants. From the ancient times these types of inks were prepared by different means. They appeared brown or dull in colour. These inks are permanent but they affect paper. Some times these inks eat away the support materials and we cannot read the matter. Ferro gallo tannate is the blue black ink suggested for records. It should contain not less than 0.4 gm. of iron per 100 c.c. as per the specification for fluid ink in IS: 2211962.

Printing Inks

Printing inks are made by mixing a dye, resin and oil. Oil is used as carrier of the ink. Resin is used to fix the ink on paper. Black ink is prepared out of lamp black, yellow, green and orange inks from chromium salts, orange from molybdenum salt, red and yellow from cadmium salts, blue from iron salts and also from a plant, *Neeli* (*Tractoris indigoferae*). The pigment azurite and verdigris are green and are natural minerals.

Inks of today are all synthetic dyes dissolved in liquids. They are either soluble in water or alcohol. Ballpoint inks are prepared by dissolving the inks in oils. There is difficulty of adherence of these inks to paper. These inks are soluble in alcohol. Permanent records are prepared out of iron gall inks, which contain iron.

Deterioration of Paper

In general, the records are made out of paper, leather, cloth etc., which are of plant or animal kingdom. Therefore, they are perishable. There are many difficulties in their preservation. If their deterioration is known, their preservation can be done in a better way. The deterioration of paper is due to two factors. They are:

1. Intrinsic factors and
2. Environmental factors

Intrinsic Factors

The deterioration of records depends on the quality of the raw materials out of which they are made. If the raw materials have short fibres the paper prepared out of them will be weak. If the chemicals used for the preparation of wood pulp are not removed completely, they will affect paper. The cellulose of the paper slowly changes chemically and is damaged. Due to the presence of lignin, paper gets brown colour and damaged. The iron impurities

entered into paper during the manufacture in due course form brown spots and they are called *foxing*. There are other reasons also available for the formation of *foxing*.

Acidity

Acidity is a property acquired by paper and allied materials due to aging. Acidity is acquired on paper in due course both internally and externally. The moisture along with the acidic gases is absorbed by the paper and the acidity of the paper is increased day by day. The fibres are broken into pieces due to chemical changes, and the strength of the paper deteriorates. The acidity of paper is measured by pH scale, which ranges from 1 to 14. A pH of 7 is neutral. If the pH is less than 7 it is acidic and above7 it is alkaline. Because of the oxidation of lignin, paper becomes brown and ultimately gets brittle.

Causes of Deterioration of Paper

Materials used in the manuscripts and books are paper, board, thread, adhesive, leather, cloth for binding cover. Usually they are destroyed due to high temperature, humidity, light, biological agents like fungi, insects like termites and improper house-keeping. Furthermore, some manuscripts deteriorate due to acidic pigments and inks. Verdigris affects paper very much and eats away the paper. Ink is converted to dark brown and later gets charred. So we should understand these causes first:

- Due to high temperature paper becomes yellow and brown.
- Fungus grows on paper due to moisture in the manuscripts.
- Presence of fungi and insects are found due to lack of proper ventilation.
- Light affects the strength and colour of manuscripts.
- Insects eat away manuscripts.
- Improper material in manuscripts causes deterioration.
- Improper book binding is harmful.

Stacking

The damaged palm-leaf manuscripts are conserved and restored by various means depending upon the type of damage and the manuscript. This is not the final duty of the archivist. There is a great task of preserving them for posterity. They should be properly stored and available for reference. They should be properly documented. Index cards may be prepared or they may be computer documented.

1. For proper care of the palm-leaf manuscripts the temperature and relative humidity of the hall in which the palm-leaf manuscripts are stored should be controlled. The temperature may be between 19±1°C and the relative humidity may be 50±5%. There are archives, manuscripts libraries where the air conditioners function during day time only. This is very dangerous as this will create fluctuations in the environment and the materials are damaged seriously.
2. The storeroom should have air circulation. Exhaust fans should be fitted in the room or openings should be made in the walls allowing air to come in and out. Termites enter the room either from the ceiling or from earth. They are called as dry wood termites and subterranean termites. Within a night they destroy organic materials like books, manuscripts and other archival materials.
3. Book lice are insects, which are small in size. Some live on materials drawn from biological origin. They eat away books, photographs, water colour paintings and paper. They also eat the resin or paste used in binding.

To safeguard these valuable manuscripts, documents and books, we should be cautious towards the enemies as mentioned earlier. We should follow the appropriate control measures. In this way we can protect our rich written heritage and culture.

Structural Characteristics

The buildings for archives, libraries, museums etc., should be designed in such a way that they are suitable for the protection of archival and library materials and manuscripts. It is very important to choose the best architectural design and the suitable building materials. Cross ventilation facilitates air circulation. Sun breakers or rain shades should be provided for the windows. It is better to choose materials, which will not be damaged by insects. If there is any need to use wood, it is advisable to use well-seasoned wood, which has anti termite qualities or the wood should be chemically treated to avoid insects. The building should be well protected from insects at the time of construction. It should be kept in mind that growth of plants very near the buildings should be avoided as the roots will damage the building foundation and the branches will scratch the building as well as they may facilitate squirrels entering into the building through them. The entry of pigeons, bats, squirrels, rats etc., should be avoided by blocking the entry points. Free entry of fresh air is good for both the staff and materials. Therefore the design should help in the free

circulation of air even in the case of electricity failure. If a garden is maintained around the buildings, the plants will absorb dust and will help in maintaining the weather. It is always better to construct the buildings away from traffic. Near the roads tall and broad trees may be grown, which absorb not only dust and noise but also provide beauty to the campus. The construction of building in the east westerly direction will avoid direct sunlight to the buildings.

Chemical Conservation

In the conservation of archival matericals and manuscripts there are five stages of conservation. They are:

1. Examination of the manuscripts and their environment,
2. Preventive conservation,
3. Interventive conservation,
4. Restorative conservation and
5. Duplicative conservation.

Examination of Materials

If examination of the situation is carefully done, proper preventive measures may be taken prior to the occurrence of defects and damages on the manuscripts and archival materials. In case the interventive measures are to be taken, the knowledge of the materials and the environmental conditions should be studied. When any restoration is found absolutely necessary, it can be done. The duplication of records is very good in case of archival materials. The duplication may be made by xeroxing, digitizing etc. The examination of physical characteristics of the environment should be made regularly. The paper materials should be checked for the acidity, movement of insects, etc. The material science of the support materials is very important to take up the conservation of manuscripts.

Preventive Conservation

Prevention is better than cure. All materials decay due to various factors. The environment, the ingredients of the material including ink, handling storage etc., should be studied to stop the decay and preserve them for posterity. Preventive conservation is discussed in detail in this book.

Interventive Conservation

Interventive conservation is done by experts or trained staff in the records office, library or museum. Various methods like fumigation, cleaning, de-acidification, lamination, repairs, strengthening etc., should be carried out.

Control of Chemical Factors

There are many means and ways by which the archival materials manuscripts etc., get acidified. Acidity gives brittleness and a bad smell to archival materials. The unwanted *'lignin'* in the raw material of paper gets decomposed and imparts acidity to paper. The absorption of acid fumes by paper also increases the acidity. Because of this, paper gets brown colour and also gets weakened. The affected paper materials cannot be brought back to their original condition by any means. But, the acidity can be removed. There are two methods of removal of acidity from the archival materials.

They are

1. Dry de-acidification or vapour de-acidification.
2. Wet de-acidification.

The first method is rather easy to handle as the archival materials and manuscripts may get de-acidified without any physical deformation. But, in the second case the records should be separated sheet by sheet and de-acidified by soaking them in chemical solutions.

Dry De-acidification

Archival materials and manuscripts get brown colour due to acidity. A chemical, which is basic in nature, can remove this in the vapour phase. The basic chemicals like ammonia, amines etc., are kept in a cabinet in which the archival materials are kept. Ammonia vapour reacts with acidic chemicals in paper and neutral salts are formed thereby the acidity is removed. When the acidity is removed, it does not mean that the paper is strengthened. The strength of the paper can not be increased by this de-acidification. Sometimes amines are dissolved in acetone and the records are soaked in it to neutralise the acidic compounds in paper. Ammonia and cyclo hexylamine carbonate are used for de-acidification. The de-acidification should be done periodically to remove the acidity. Dry de-acidification is good for the archival materials, as this will not disturb any soluble ink present in the archival

material. The records or manuscripts may be kept in a fumigation chamber and the liquid ammonia may be kept in the lowermost rack and the chamber kept closed for 48 hours.

Wet De-acidification

Limestone had been used in paper manufacture since early times. Sodium-bi-carbonate had been used to preserve materials made out of cellulose. Barrow in the middle of 1946 used a two staged de-acidification method for archival materials. In the first stage, the archival materials, which were affected by acids, were kept immersed in 0.15% solution of calcium hydroxide for 20 minutes. Then it was kept in 0.2% calcium bi carbonate solution for 20 minutes. Barrow was able to remove the acidity from documents by this method. This method is even today successfully followed in the Indian archives. By this method archival materials absorb moisture and if they are not properly handled they will get torn. Anyhow, this method is not suitable for those documents, which have writings with water-soluble inks in them.

If 1% barium hydroxide in methanol is sprayed on the document, which contain water soluble inks, the acidity of the document is removed. The excess salt settled on the surface acts as a reserve against the future absorption of acids. Use of magnesium methoxide and diethyl zinc separately in the stack room removes acidity from the archival materials in the stacks and storage. This is called the mass de-acidification.

Protection from Biological Agents

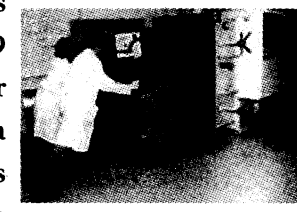
In an ambient condition of temperature and relative humidity biological growth is facilitated on paper materials. In order to be free from the biological growth i.e. insects, worms, beetles, moulds, fungi etc., the paper materials should be kept in an ideal condition of temperature and relative humidity (Temp. : 19 ± 1°C ; R.H.: 50 ± 5%). The help of some preventive chemicals may control the growth of the biological agencies.

Fumigation

Fumigation is a process of treating archival materials and manuscripts with chemicals in the vapour phase for about four to six days. By this, the vapour penetrates into the leaves of the archival materials and the insects or fungi are either driven away or killed. When the archival materials are received after reference or used by scholars, they may be fumigated and then kept in their position. This avoids the biological infestation. Some of the household

microbial agents that damage paper and other allied materials are - mildew, mould, fungus, silverfish, cockroach, white ant, bookworm (*Gastrallus Indicus*). For complete eradication of bookworms, re-fumigation of the affected archival materials / manuscripts is necessary after 21 days as the eggs laid. Fumigation with camphor by bookworms hatch out after 21 days. The hatched out larvae should be eradicated. Whereas maintenance of neat and tidy storage and keeping optimum temperature and relative humidity helps in reducing susceptibility of damage by these agents, the precautionary measures are further reinforced by using insect repellent chemicals like naphthalene, camphor, or other preparations in the stacked or storage area. Use of insecticidal solutions at places where these insects hid or breed e.g., walls, dark and dingy corners and below the shelves, keep a check on these insects.

Insect infested materials need sterilisation with toxic fumigants in air tight fumigation chambers. Wooden as well as steel chambers are being used for fumigation with thymol and para dichloro benzene and mixture of ethylene dichloride and carbon tetra chloride. In archives and libraries only these insecticides and fumigants find use, as they do not adversely affect the stability of archival materials. National Archives of India, New Delhi and Tamil Nadu Archives, Chennai have installed vacuum fumigation chambers in which ethylene oxide and carbon-di-oxide gases in the ratio 1:9 are sent into the chambers stored with archival materials under vacuum for 4 to 5 hours. Small archives and libraries may have a fumigation chamber to fumigate the archival materials. The fumigants will be suitable if they can be vapourised around the room temperature. The chemicals, which are used to eradicate biological growth, may be classified as follows:



Stacks of Manuscripts Kept for Fumigation

1. Insecticides
2. Fungicides
3. General biocides

Insecticides

The insecticides have the property of killing the insects. They include arsenic oxide, aldrin, dieldrin, lindane, pyrethrum and chloropyriphos. But, aldrin, dieldrin, pyrethrum are banned from use in the European countries. They kill the insects by poisoning them. Naphthalene, para dichloro benzene etc., kill the insects by suffocation. They are called as insect repellants. These are also not preferred as constant inhaling is not good for health.

Arsenic oxide, Durshban TC etc., eradicate termites completely. These chemicals may be dissolved in a suitable solvent either in kerosene or water and the drilled holes at a distance of about a foot along the joint between the floor and the walls may be filled with the insecticide solution and then covered with sand and finally with the flooring material. These chemicals are harmful to the users too. Therefore utmost care should be taken in handling them due to their poisonous nature. Dieldrin is also poisonous. In a volume of $1m^3$ only O.25 mg of dieldrin should be present. This will kill silverfish. Nowadays any chloropyriphos chemical available in the market may be used for this purpose.

Silverfish and cockroach may be eradicated by spraying Lindane (Hexa chloro cyclo hexanone) either as powder or solution. This will damage ink. Therefore, this may be sprayed or brushed where there is no writing.

Baygon (ortho isopropoxy phenyl methyl carbonate) may be sprayed as solution (0.5%) in corners and cracks to eradicate cockroaches.

Pyrethrum is a natural insecticide made from the dried flower heads of *C. cinerartifolium* and *C. coccineum*. It is also synthetically prepared and the chemical is piperonyl butoxide. Pyrethrum is sprayed to eradicate cockroach, silverfish etc.

Para dichlorobenzene is a universal insecticide, which kills booklice, beetles by suffocation. The use of this is also now slowly given up.

Drione (Pyrethrins 1.0%, piperonyl butoxide 10.0%, amorphous silica gel 40.00%-dust form) has broad spectrum of insecticidal activity for the control of crawling insects like cockroaches, booklice, wasps, beetles etc. It can be dusted or sprayed.

Naphthalene kills beetles. If the archival materials are fumigated with naphthalene the beetles are killed.

Insecticides for rodents are two types. One variety of these insecticides kill the rodents by solidifying blood when they are eaten e.g. Warferin, kaumaberil. The other variety is one, which kills by forming a gas when the rodents eat the chemical. When the rodents eat zinc phosphide, phosphine gas is formed inside the intestine and they die.

Insect Traps

It is better to find out the type of insects, which live in archives, libraries, museums etc., by suitable means and then treating them suitably. Insects are normally killed by using high

voltage grid traps, by immersing them in liquids etc. But these methods cannot be used in archives etc. The insects, which come to archives, may be caught by installing a yellow prism like cardboard trap having applied adhesive in the upper portion of the base. The insects, which are attracted by yellow colour, enter inside the prism and are caught stuck. By identifying the insects, suitable insecticides may be applied by suitable means in archives, libraries or museums and the insects can be eradicated.

Insect Trap

Fungicides

In moist condition fungi grow very easily on archival materials, which are organic in nature. Therefore, archival materials should be treated with suitable fungicides. Fungicides may be organic or in-organic chemical compounds. Thymol is a universal fungicide. If the fungal attacked archival materials or manuscripts are fumigated in a fume cupboard/chamber with thymol at about 52°C (20 grams/m^3) for about a week the fungi are killed. The thymol dissolved in alcohol may also be sprayed in the stacks. Inhaling thymol for long time is not advisable. A blotting paper dipped in 10% solution of ortho phenyl phenol and dried may be kept between the organic archival materials to get rid off fungi. The Central Leather Research Institute, Chennai did some research on fungicides and the material was marketed in the name of *Nifol.*

A 0.5% solution of para nitro phenol in alcohol will drive away fungi. In order to get rid off fungi a spray of thymol mercuric chloride mixture solution in ether-benzene mixed solvent may be given. A 0.5% solution of penta chloro phenol in water also may be used to remove fungal growth.

Biocides

Ethylene oxide and carbon-di-oxide mixed gas in the ratio 1:9 kills all types of biological agencies and thus archival materials are preserved. It is called as ethoxide. *Vapona* is another chemical, which is being used for this purpose. Durshban TC is a chloro pyriphos compound used to eradicate insects, termites etc.

Non-toxic Methods

When the insecticide chemicals are used they stay over the archival materials and some side effects have been noticed both on the materials and human beings who handle them.

Nowadays archival materials are exposed to low-nitrogen atmosphere for a few hours to eradicate insects and fungi.

Cleaning of Materials

If the archival materials are found stained and got brown colour also with foxing marks, they should be cleaned. Unless it is absolutely necessary, archival materials should never be subjected to chemical cleaning.

Stain Removal

Archival materials are organic in nature. Depending upon the ink, they should be cleaned using suitable solvents. The common solvents are water, acetone, alcohol, toluene, hexane, benzene, pyridine etc.

The oil, crease, wax etc., from the archival materials may be removed by using toluene, hexane, benzene, pyridine, petrol etc. A mixture of toluene and hexane is used to remove the gum from the cello-tapes. Fungal attacked paper may be cleaned with the help of hydrogen peroxide in alcohol. Lac and varnish can be removed by acetone. A mixture of hydrogen peroxide and alcohol in equal quantities removes the stains made by flies and mosquitoes. Tea and coffee stains are removed by using 2% solution of potassium per borate in water. The stains due to iron based inks are removed by a saturated solution of sodium formaldehyde sulphoxylate in water. The stains due to iron gall inks are removed by 2% chloramine-T in water followed by 5% oxalic acid solution or 10% citric acid solution. Rubber stain is removed by carbondisulphide. Oil paint is removed by ethanol and toluene. Coal tar is removed by carbon tetra chloride or chloroform. Red ink is removed by 1% solution of ammonia or methylated spirit. Fly marks are removed by hydrogen peroxide in water/alcohol. Water stains are removed by immersing the document in water for 20 minutes followed by the immersion in hot water for 20 minutes. Eraser should remove superficial stains before the documents are immersed in any chemical solution. The leaves should be numbered using pencil. The paste used in bookbinding should be removed by suitable means. The use of collaginase, an enzyme, is used to soften glues. Therefore, much care should be taken to remove the pastes used without damaging the archival materials.

Bleaching Methods

The dark brown colour and foxing marks in documents containing water insoluble inks may be removed from the documents by the use of chemicals like chloramine-T dissolved in water (saturated solution).

Chloramine-T in alcohol may be used for water-soluble inks. This method does not allow the chemical to contaminate the paper. Chloramine-T is a bleaching agent, which after the bleaching process gets evaporated and therefore no residual chemical is left behind. There is no need to wash the paper after the treatment. Chloramine-T solution should be prepared just prior to the treatment to have the maximum effect of the chemical. Old solution should not be used.

10% sodium hypochlorite in water may also be used as a bleaching agent. The document is kept on a polyester film/glass plate, moistened and dipped in the solution. It is taken out, washed in water and dipped in a 2% solution of sodium thiosulphate and washed well in water to remove the adherent chemicals. Chlorine is removed by washing and the document gets a fresh cream colour.

Water stain, foxing marks, fungal growth etc., may also be removed by chlorine dioxide. 5% sodium chlorite is taken in a tray to the required amount and kept inside a fume cupboard. Then, formaldehyde to form a 2% solution is taken and poured into the solution. The wet document with proper support is dipped in the yellow solution, where chlorine-di-oxide formed, for a few seconds to a minute, taken out, washed in running fresh water in a tray and naturally dried after thorough washing. This type of bleaching is better than sodium hypochlorite bleaching. If the immersion of the document is injurious to the document, the bleaching can be effected in the vapour phase also. This has been successfully carried out by the author and found successful.

Some important documents may contain the signatures of great leaders. If the document is stained a lot and the signature is to be preserved very well, the signature portion may be covered, with a cellulose acetate foil using acetone. The document is bleached by any method described above. After the bleaching process, the cellulose acetate film may be removed by applying acetone. A particular portion of the document may also be protected with the help of 5% poly methyl methacrylate in acetone. The cellulose acetate may be removed after bleaching with the help of acetone. The soluble inks may be avoided from dissolution in this way.

Glazing of Paper

The paper documents, which were chemically treated, will be free from earlier glazes and appear thin and weak. If glazed, the paper will be strengthened. A 0.3% gelatin in water is prepared, the paper is dipped in it and the excess gelatin is squeezed out, dried and kept under two glass sheets keeping oil paper to avoid wrinkling. Methyl cellulose grade A15 is used for glazing paper manuscripts.

Removal of Creases

The creases in paper may be removed by moistening the creased area with cold or hot steam or damped cotton swab, silicon paper is kept over it, and pressed with hot iron. If creases are too many, then the record is put upside down, covered with a moistened blotting paper, pressed to remove the creases and kept under a glass plate. The creases are removed.

Pastes Used for Repair

The choice of adhesives in archives and libraries are very important. If animal glues and plant resins are used, when dried they wrinkle due to contraction of paper. Therefore, suitable pastes are used for archival use. Synthetic adhesives are avoided mostly. While preparing the pastes suitable insecticides are used.

1. Dextrin Paste

The paste prepared out of 2.5 kg dextrin, 40 gms of clove oil, 80 gms of barium carbonate, 40 gms of saffron red powder, dissolved in 5 litres of water is dextrin paste. In place of dextrin *maida* flour may be used.

2. Flour Paste

Paste is prepared by dissolving 250 gms of *maida* flour, 40 gms of barium carbonate, 40 gms of red powder in 5 litres of water.

The paste preparation is made as follows:

In a shallow vessel the water is brought to about the boiling stage. Dextrin or *maida* flour is added while stirring. Barium carbonate is also added while stirring the mixture. Then red powder and clove oil are added and heated for about 8 minutes.

Composition of Starch Paste

Starch (Maida)	:	1 Part by weight
Formalin	:	About 3% by weight of the starch
Glycerin	:	About 2% starch by weight
Water	:	About 4 parts by weight

Preparation of Starch (Maida) Paste

Small amount of *maida* flour is mixed with sufficient amount of water in a copper or brass vessel and mixed well with out any lumps or nodules of flour. The mixture is then cooked very carefully using a-heater or fire till froth comes out. It should be seen that no charring of the *maida* paste takes place. Glycerin is mixed at this stage with stirring. When the heat of the paste comes to the room temperature, formalin is added little by little and the paste is thoroughly stirred to have proper distribution of formalin.

Book binding paste was prepared by mixing 1 part of flour in 5 parts of water and 3% copper sulphate was then added. 2% glycerin was also added and paste was prepared by heating. Nowadays formalin is used instead of copper sulphate as copper sulphate accelerates acidification of paper.

In Japan and European countries the pastes prepared in the traditional way are used. After preparation the pastes are stored in special chambers for years together for seasoning of the paste.

Carboxy methyl cellulose is used for the repair of paper materials now a days. This can be prepared in cold condition by mixing the powder in water. This can be prepared in alcohol also. Similarly methyl cellulose is also prepared as above and used as an adhesive for paper manuscripts.

Restoration of Records and Manuscripts

Traditionally silk was pasted on both sides the records to protect them. But, silk is also an organic material therefore the record was not protected as thought off. Instead of silk chiffon cloth (synthetic polymer) was used in the lamination of documents. It is a reversible method. The chiffon pasted can be removed if required. But this method is being given up as the paste used is eaten by insects and the weak documents crumble and the legibility is

low. But there are many Archives in the country still continue this process. Nowadays many materials are used in the lamination of documents. Tissue paper, chiffon cloth, polypropylene, polyester etc., are used as laminates. All materials are not good. Please refer to the chapter on Lamination.

Restoration of Inks

Since the tannin in the iron gall ink disintegrates, the letters discolour. As only iron oxide is present in the letters they appear dull. If the iron in the letters is subjected to chemical change the letters may be restored. The discoloured letter is iron oxide. Potassium ferro-cyanide with little hydrochloric acid may be taken in a brush and applied very carefully on the letters. The document may be kept in between two sheets of glass for few minutes. Now blue letters are seen. This is due to the formation of ferroso ferri cyanide, which is deep blue in colour.

By the application of ammonium hydro sulphide solution the letters may be restored. But it is not so permanent as that of the earlier one. If a 2-3% solution of tannic acid is applied over the dull iron gall ink letters, they get back their black colour.

Before the letters are restored the documents may be photographed in UV light and preserved. Anyhow care should be taken while chemicals are used to replenish the inks in the archival materials.

Restoration of Pencil-written Manuscripts.

Pencil lead is made up of carbon. Any writing with pencil on paper or any such support materials will be only a surface feature. Any rubbing will remove the writting. Therefore for the conservation of pencil-written manuscripts, it should be noted that no rubbing, cleaning should be done. If necessary the manuscripts may be beached by vapour Phase method. No encaptulation should be made as the electrostatic force of the polyester will attack the carbon particles there by letters will be lost.

Restoration of Maps

Maps are one of the items preserved in archives and libraries. Generally they are preserved in folded form. They break along the folds due to age and use. They cannot be restored simply as that of the documents. Some special efforts should be made to restore them. The broken piece must be kept on a glass plate upside down. The torn portions are fixed using tissue paper bits using an adhesive. When dried, the map should be placed upside down on an oil paper. Chiffon cloth, slightly smaller than the map, should be kept at the backside of

the paper map and *maida* floor paste is applied to adhere it to the paper map. If necessary the map may be moistened by a swab before pasting. A squeeze roller may remove the excess paste. Then a brown paper strip is pasted at the edge of the map all around in such a way that a portion is on the map and the remaining portion is on the table. It is allowed to dry. During the drying process the wrinkles, creases etc., are set right. When dried the brown paper is cut, removed from the map. The map may be trimmed at the edge. We can get a smooth laminated map with out creases or wrinkles. This type of stretching is called brown paper stretching.

Matting and Framing

Most good framers know about archival mounting, protecting both the front and back of the maps, the avoidance of trimming margins and numerous other details. Conventional glass, as noted above, provides reasonable UV and surface protection. It is better to avoid no-glare glass.

Physical Handling

Keep your hands clean while handling, and use them both to lift the item evenly. This minimizes bending, creasing, tearing, etc. Try not to store them stacked loosely on top of one another, as molds, acid, and other materials can transfer to items in close contact. Only use archival materials (acid free preferable to buffered) for mounting and simple repairs (very simple). Even if a map has been mounted on a stiff surface, be very careful, as the mounting material may be brittle or split. If you are rolling a map, be careful not to roll it perpendicular to an existing centerfold: it should be rolled parallel to the fold.

LAMINATION OF RECORDS AND MANUSCRIPTS

A manuscript is any written document that is put down by hand, in contrast to being printed or reproduced some other way. Information may be hand-recorded in other ways than in manuscripts, as inscriptions that are chiseled upon a hard material or scratched (the original meaning of *graffiti*) as with a knife point in plaster or with a stylus on a waxed tablet, (the way Romans made notes), or are in cuneiform writing, impressed with a pointed stylus in a flat tablet of unbaked clay. The word *manuscript* is derived from Latin, *manu scriptus*, literally meaning 'written by hand'.

Lamination

Lamination is a process whereby a plastic film is fused to paper using heat. This treatment is very difficult to reverse. In addition, the plastic used for lamination is not stable over the long-term and as it shrinks it will pull the paper with it, causing severe damage. The application of heat during this process will also contribute to deterioration.

History of Lamination

Various lamination methods have been practiced by conservators in various parts of the globe. Lamination was once the method of choice for preservation of paper records, documents, manuscripts.

Chiffon Lamination

A layer of extra-thin but strong silk tissue applied to mend or strengthen a leaf in a book or other document printed on paper or a manuscript was called as chiffon silk. Chiffon-silk mending was extensively used between about 1920 and 1960. Chiffon is a French word derived from 'chiffre' meaning rag. Chiffon means a very fine transparent silk or nylon fabric. Hugo Ibscher studied the use of chiffon-silk for lining ink-corroded artifacts at the studio of Franz Ehrle in Rome and shared his knowledge all over Europe. The results of his work can be accessed in many libraries in Europe (for instance at the Staatsbibliothek Preußischer Kulturbesitz Berlin). Manuscripts treated in this manner may be detected by pieces of thread sticking out of the edges.

Conservators removed previous lamination in repeated solvent baths of acetone and then removed old mends. They re-mended tears with Japanese tissue and starch paste, a standard

conservation technique that, unlike the old-fashioned lamination technique, can be easily undone, or reversed, with water.

The Defects of Chiffon Lamination

1. Even though the chiffon mending of paper documents is reversible, very brittle paper gets lost as the medium used to reverse the paper is water. This will bleed the ink if the ink is not a permanent one.
2. The size of the folio becomes very large and the legibility is poor.
3. The chiffon mended documents are susceptible to biodegradation as the paste used was starch.
4. Since the surface is rough, it facilitates dust accumulation resulting in the absorption of moisture attracting mould growth.
5. The cost is also high and it is aesthetically not appealing.
6. When xeroxed or digitised, the chiffon's pattern is also recorded reducing the visibility of the written details.

Hot Lamination

Hot lamination was done sandwiching the manuscripts in between two sheets of polymers. Hot laminators are the most common types of laminators. They use heat (180 to 300°F) to laminate documents and other flat items. The heat melts an adhesive that results in the plastic laminate sticking to the original material being laminated.

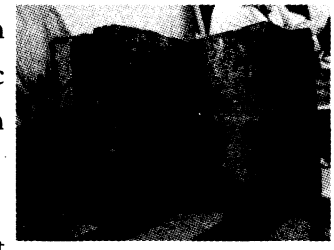
Hot lamination technique is used with any flat items that do not include inks or materials that will run or melt when exposed to high temperatures. Hot laminators provide a better quality, more durable lamination that is more resistant to wear and tear. But the materials used decompose acquiring acidity and they crumble. More over this method is irreversible. This is not suitable for laminating manuscripts/documents.

Cold Lamination

Cold lamination with the help of cellulose acetate foil, tissue paper and acetone by hand is the method followed recently, in 1960s, and is now not recommended as the cellulose acetate produces acetic acid and hydrochloric acid spoiling the documents laminated.

Cellulose Acetate Lamination

Cellulose acetate foils along with tissue papers have been used for lamination between 1950 and 1960. Nils Gärting proposed embedding of damaged papers in acetate or PVC films in exceptional cases only and emphasised the irreversibility of such a procedure (Gärting 1963: 111). Manuscripts treated in this manner are today strongly yellowed and damaged by acetic acid or hydrochloric acid emitted by the film material or migration of its external plasticizers.



Damaged Laminated NCC Volume

At the end of the 1980s, successful de-lamination of parchment manuscripts, dated from the 8th century, was achieved in Vienna ('Karolingisches Evangeliar', Wächter 1987: 34 - 38) and Brussels (Codex Eyckensis, Wouters et al. 1990: 495 - 499, 1992: 67 - 77). PVC-film material (brand name: 'Mipofolie' 2) was removed by immersion of the artifact in ethanol : amyl acetate 4:1, sometimes adding butyl acetate (Vienna), or the film material was mechanically removed after pre-wetting with ethanol : amyl acetate 4:1 (Brussels). Recently, the PVC laminated printed NCC Catalogues in the department of Samskrit have been delaminated with the help of acetone and amyl acetate.

Damage from the Lamination Processes

The first problem associated with lamination is damage caused by the lamination process itself. The application of heat and pressure during lamination was sometimes poorly controlled, resulting in burnt or scorched papers. High temperatures caused some media to melt or bleed, damaging wax seals, discolouring pigments, or blurring lines. Other media may have been partially solubilised, that is, some pigments or inks may have run or smeared due to a chemical reaction during the lamination process.

Aesthetic Problems

In addition, laminated documents often have aesthetic problems. The cellulose acetate laminate greatly alters the appearance and texture of documents, giving the paper a shiny surface with an uncharacteristic hard, plastic feel. The addition of tissue in the laminating process helped to reduce the shine, but unfortunately also reduced the clarity of the original documents, altering their colours and appearance. The different kinds of presses used to

apply pressure during the lamination process produced a variety of new surface textures on the documents. The overall result is a hazy look that one archivist/librarian/curator has likened to the appearance of plastic placemats. In other cases, the laminate renders the documents translucent; writing or images on the back of a page may show through, making them difficult to see.

Intrinsic Problems

Lamination may also exacerbate problems that were already present in the documents themselves (inherent vice). If, for example, a document on poor quality paper was not de-acidified prior to lamination, the layers of plastic encasing the item may trap acids within the laminate, causing the paper to yellow and become brittle. In other cases, torn documents were repaired using inappropriate methods before they were laminated. Repairs with pressure-sensitive tape, for example, are potentially damaging for any papers, but lamination exacerbates the problem; the heat used in the lamination process can kick off chemical reactions, while the carefully sealed layers of laminate trap by-products, creating a harmful microclimate for the paper. Encased in plastic, these damaging repairs may be difficult for conservators to treat.

Deterioration of the Laminates

Deterioration of the materials used in lamination may cause additional damage to laminated documents. Remember that the lamination process drives the plastic laminate into the paper itself. When the plastic begins to break down, the document it encases will also suffer. The most widely used laminate, cellulose acetate, is inherently unstable. Like the cellulose acetate film base used in movies, the laminate decomposes through a chemical reaction that causes the bonds of the cellulose acetate molecule to break down. This decay process releases acetic acid from the molecule, producing the strong vinegar or ammonia odour that is called *vinegar syndrome*. As the laminate deteriorates, it may warp, stretch, or peel, placing great stress on the paper. In some cases, the stresses from deteriorating laminate are literally splitting the paper apart internally.

As cellulose acetate breaks down, it may exude plasticizers, the chemicals added to increase the flexibility of the otherwise, a brittle film. Plasticizers exuded as a liquid may collect on the surface of the laminate, giving it an oily appearance and often leaving the surface quite sticky. When exuding leaves of laminated papers come into contact with each other, they

may stick together in a block making them unusable. The degradation of plasticizers also reduces the flexibility of the laminate itself; as this happens, documents are in danger of cracking, chipping, or completely snapping apart. This is particularly troublesome with laminated leaves that have been put in post bindings — a common method of binding that places considerable stress on the bound edge of vulnerable documents.

Encapsulation

Encapsulation, encasing and then sealing documents between two sheets of inert polyester film (*i.e.*, Mylar type D), is the perfect way to protect items that are heavily used, fragile, or exhibit pieces. When all the leaves in a book are extremely weak and/or brittle and require overall support, encapsulation in polyester film and post-binding may be appropriate. Polyester film is a clear, inert plastic that provides excellent support for fragile paper. Each leaf of the book is placed between two sheets of polyester film, and the film is sealed along all four edges. Polyester is a category of polymers, or, more specifically condensation polymers, which contain the ester functional group in their main chain. Usually, polyester refers to cloth woven from polyester fibre. Ultrasonic welding is the preferred method of sealing the film. If the leaves of a book are still in folio form, the folios will usually need to be cut along the fold to facilitate encapsulation. However, paper requiring encapsulation is usually so fragile that any folds that once existed have already broken. Polyester film has an electrostatic charge. For this reason encapsulation is not recommended for leaves that have loose, flaking, or friable media because the electrostatic charge may loosen media even more. Pencil written records should never be encaptulated as the electrostatic force will remove the pencil writing. The encapsulated leaves can be bound together in what is referred to as a post-binding. Boards (covers) are attached to the encapsulated leaves by means of screw posts, which pass through the covers and polyester film to produce an album-style binding. Although the boards can be covered in almost any material, they are usually covered in cloth. Encapsulation of documents is being followed in the State Archives, Bhopal since a few years.

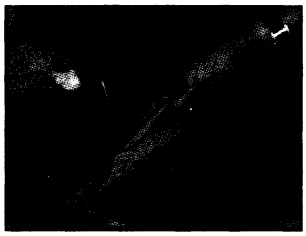
The International Organization for Standardization (ISO) paper industry standard is considered the most consistent way to compare paper weights. The ISO measures weight in grams per square meter (gsm).

Today, encapsulation of items within acid-free sheet protectors has made the preservation process more efficient. Most experts recommend preserving precious and valuable documents in this manner versus the old method of lamination. Encapsulation allows the historical

item to float freely and can easily be removed when necessary. But it should be seen that the acidity is removed from the paper completely before encaptulation.

Tissue Paper Lamination

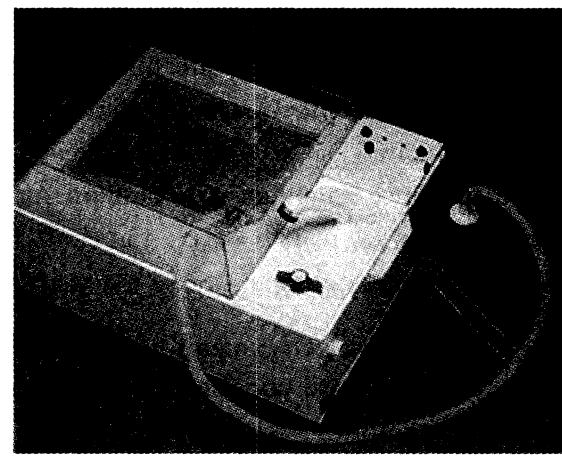
Tissue paper lamination is widely practiced as it is the latest harmless method of mending/ repairing of paper documents. Conservators remove previous lamination in repeated solvent baths of acetone and then remove old mends. They re-mend tears with Japanese tissue and starch paste, a standard conservation technique that, unlike the old-fashioned lamination technique, can be easily undone, or reversed, with water. Tissue paper is a thin, strong, translucent paper made for use in crafts, as well as for wrapping, lamination of paper documents and other applications. Waxed tissue paper is coated with wax so that when it is heated with a warm iron, pieces will stick together. Japanese mending tissue is a kind of tissue paper used in art conservation to mend or repair paper that is old or worn. Honeycomb tissue paper, sold in pads, is an accordion folded paper for making three-dimensional centerpieces, ornaments, and decorations, and crepe paper is also a variety of tissue paper. Acid free tissue paper is used in preservation, in folded items such as fabric, and for interleaving. In India tissue paper is manufactured in Rajasthan and Tamilnadu.



Tissue Paper Lamination of Paper Manuscripts

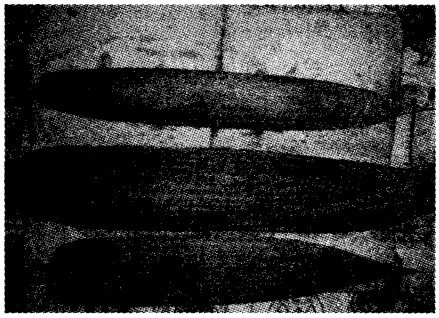
Leaf Casting

Certain portions on paper sometimes found lost due to insect attack, brittleness, mishandling etc. There was a traditional practice of filling the holes with paper pulp. Following this method, Alsale, an Israelite invented a machine called the Leaf Castor to cast the lost portions of a document. This machine was subjected to certain improvements in Austria and finally got its full utility in Spain. This machine fumigates, de-acidifies and casts leaf at a time when the document is inserted. Since, water is used in this method documents with water soluble inks cannot be mended. Some of the State archives have leaf casting machine including the Tamil Nadu Archives, Chennai.



Paper Leaf Caster

RECORDS AND MANUSCRIPTS ON BAMBOO STRIPS


Bamboo manuscripts

Manuscripts on bamboo strips are found here and there in museums, manuscripts libraries etc., in this country. Bamboos are a group of woody perennial evergreen plants in the true grass family, Poaceae, subfamily Bambusoideae, tribe Bambuseae. Some of its members are giants, forming by far the largest members of the grass family. There are 91 genera and about 1,000 species of bamboo. They are found in diverse climates, from cold mountains to hot tropical regions. When treated, bamboo forms a very hard wood which is both light and exceptionally tough. In tropical climates it is used in elements of house construction, as well as for fences, bridges, toilets, walking sticks, canoes, drinkware, furniture, chopsticks, food steamers, toys, construction scaffolding, as a substitute for steel reinforcing rods in concrete construction, hats, martial arts weaponry, abaci and various musical instruments. Bamboo is also widely carved for decorative artwork. When bamboo is harvested for wood, care is needed to select mature stems that are several years old, as first-year stems, although full size, are not fully woody and are not strong. Bamboo strips are used as such and the convex surface is used for writing. Some times, the bamboo strips are worked flat and written with stylus specially made for this purpose.

Damages Caused

Bamboo wood is easily infested by wood-boring insects unless treated with wood preservatives or kept very dry. Climatic variations affect materials of bamboo as they are organic in nature. When moisture level is high above 65% fungi and insects are attracted. Insects are the other main enemies. They are wood-borers, white ants, cockroaches, etc. The acids produced by mould metabolism permanently etch the surfaces. Dust accumulation is also found. Because of the accumulation of dust and fungi accretions the details are not visible.

Physical Treatment

Cleaning with vacuum cleaner is the best way of removing the loose dust. Brushing with soft brush can also be done very carefully. Airbrasive method of cleaning is one of the

physical methods of cleaning. The airbrasive process employs a system of grit spraying, which is so refined and controlled that it may be used to clean the bamboo manuscripts disfigured by corrosion products, mud, dusts and other types of loose, non-greasy dirt which might have been accumulated during use, improper storage or during exhibition where the manuscripts were not protected by cases. Good conditioned bamboo manuscripts may be cleaned with dolomite airbrasive cleaning.

Chemical Treatment

Bamboo manuscripts are organic and are prone to all types of deterioration. Due to usage they are adherent with oily or greasy coat. All such materials when added to the museum collection, they should be fumigated for the eradication of insects and fungi with para-dichloro-benzene and thymol respectively. They may be fumigated with methyl bromide. Greasy bamboo manuscripts may be cleaned with solvents such as acetone, alcohol etc., and dried. The writings may be inked by black soot with citronella oil.

It is always better to give protective coating to the bamboo manuscripts with 2% solution of poly vinyl acetate in acetone. The weakened bamboo manuscripts may be consolidated by injecting with 10% Paraloid B 72 in xylene.

RECORDS AND MANUSCRIPTS ON IVORY

Ivory Manuscripts

Bone and ivory were early raw materials for carving out artifacts. Bone was used to make fish-hooks, arrow heads, tools, implements etc. Ivory was used to carve, write, etch, stain, paint, gild, inlay with metals and with precious and semiprecious stones. It is also used to inlay on wood and for veneering. Many ivory plates with writings are also found in museums and libraries. Ivory manuscripts are prepared by making strips of ivory sheets. Inks were used to write on ivory. Some times paintings were also done on them.

Composition of Ivory

Ivory materials are indistinguishable from bone by mere sight. The main inorganic constituents are calcium phosphate associated with carbonate and fluoride and the organic constituents such as *ossein.* Both have cellular structure. Ivory has a hard and dense tissue known as dentine, which results in striations. The striations may be seen radiating from the centre of the tusk.

Deterioration in Ivory Manuscripts

Ivory is *anisotropic* having directional properties and for this reason ivory manuscripts are easily warped and cracked upon exposure to heat and damp. They are decomposed by the prolonged action of water due to hydrolysis of the *ossein*. Acids disintegrate them.

Being porous and of light coloured ivory manuscripts are easily stained. They tend to become brittle with age and they lose their natural colour when exposed to sunlight. When buried in the ground for prolonged periods of time they are disintegrated either by salt encrustation or by water. With the onset of fossilization, the organic content gradually disappears and the remaining calcareous matter becomes associated with silica in the form of quartz and with mineral salts derived from the ground. Old ivory manuscripts often have a yellow colour and this is accepted as a form of *natural patination*, which may help to enhance the appearance.

Conservation of Ivory Records and Manuscripts

There are various methods of conservation of ivory manuscripts. Depending upon the type of defects the treatment varies.

Removing Surface Dirt

Accumulated dirt, soot and grease obscure the beauty of the manuscripts on ivory. If the condition of the ivory manuscript is fairly good, a 1% solution of neutral soap solution in water is brushed on the surface and the dirt is removed with cotton swabs. One should keep in mind that writing is made on the surface of the ivory sheets. Prolonged contact with water should be avoided. When fragility is observed the procedure is adopted with soap solution in rectified spirit.

Removing Soluble Salts

Excavated ivory manuscripts are found to contain absorbed salts, which tend to crystallise out effecting disintegration, if they were found buried in salty ground. The removal of salts from ivory manuscripts is extremely difficult. The soluble salts should be dissolved out by water. But, prolonged immersion or washing will damage the structure of ivory and it may warp. The soluble salt-encrusted manuscripts are immersed in distilled water for 5 seconds and is repeated a number of times with fresh distilled water. Then, two washings in 95% alcohol are made. Finally the ivory object is immersed for one minute, and dried in air.

Removing Insoluble Salts

Removal of incrustations of calcium carbonate or calcium sulphate from ivory manuscripts is a professional conservator's job. A small area of about 1 square centimeter is taken and brushed with a 1% solution of hydrochloric acid for a few seconds and the reacted material is removed immediately by a blotting paper. This is repeated. The incrustation is removed by means of pin or scalpel without making any scratch or abrasion. In order to remove the traces of acid the object is washed in several changes of distilled water for a few seconds at a time and then dried by alcohol and finally with ether. If only calcium sulphate is present it should be removed by mechanical means even by vibro-tool very carefully provided the object is strong enough. Otherwise it may be left as such.

Strengthening

When ivory object is weak, it may be strengthened by impregnating it with a 5% solution of polyvinyl acetate in toluene. This may be done 3 or 4 times to do a justification. Fragile manuscripts may be vacuum impregnated. During excavation, a water emulsion of poly vinyl acetate (P.V.A.) or polymethacrylate may be used to strengthen wet and soft ivory manuscripts before removal of the object. Ivory manuscripts may be given a protective coating of 2% P.V.A. in toluene.

Restoration of Ivory Records and Manuscripts

In the restoration of ivory manuscripts suitable adhesives, which will not be affected by humidity, are used. Nitro cellulose based adhesive is good for restoration. Water-soluble adhesives should never be used.

General Care

Since bone and ivory manuscripts are porous and are easily scratched, stained etc., they should be wrapped in a clean soft acid-free tissue paper and kept on padded shelves or in padded boxes.

Very badly affected manuscripts should be kept in showcases, which are provided with silica gel with self indicator to control relative humidity by absorbing moisture.

RECORDS AND MANUSCRIPTS ON TEXTILES

Cloth is one of the materials on which man kept his records. Records on silk cloth are preserved through out the world. Many *kalamkari* textile pieces in which writings are found are in the museums. Cloths made out of natural fibres and synthetic fibres. In South India many *kalamkari* writings are preserved. Many libraries, oriental manuscript libraries and museums have preserved records on cloth and silk.

Kalamkari

Kalamkari is an ancient craft of printing and painting textiles with vegetable dyes. It is another category of cloth painting. It is named so as the painting is done with pen (kalam = pen). The dye becomes the part of the fabric and does not superficially lie on the surface like paint.

Kalamkari textiles originated during the 17th Century in places like Masulipatnam and Kalahasti of Andhra Pradesh and later spread to other parts of India. They were used as canopies over idols during festive occasions and as panel on walls or as costumes. Temple cloths were made at centres such as Salem and Kumbakonam of Tamil Nadu in the early 20th Century, but the long representative of this tradition is confined today at Sickinaikkenpet, Thanjavur district, Tamil Nadu. The samples made in the Masulipatnam area show that figurative *Kalamkari* are now being drawn free hand or in combination with block printing. These are called illustrated textile documents.

Degradation of Textiles

Degradation on the textiles is brought about by the biological activity on the cloth, environmental factors such as humidity, light, heat, dust, and man made problems such as improper handling, improper storage, vandalism, neglect etc.

Conservation Measures

As far as the maintenance of the textiles is concerned, they should be free from dust, acidic oxides, such as oxides of carbon, nitrogen and sulphur, high relative humidity etc. The acidity on the textiles may be removed by dry de-acidification or wet de-acidification. Ammonia vapour de-acidification (dry de-acidification) is always better in this case. As far as the textiles are concerned, it is always better not to use water for cleaning. Dry cleaning

can be done to remove dirt, grease etc. Cleaning may be done with solvents depending upon the fastness of the dyes used. While cleaning, chiffon cloth may be spread over the textile which is placed on a glass plate and the cleaning solution (water or a solvent and nutral soap) may be poured over and brushed gently using a soft brush. The lather formed should be removed by washing with the solvent used. Before using a solvent, the textile should be tested for the colour fastness.

Mending of Records and Manuscripts on Textiles

The textiles may be mended in many ways. One method is darning with similar thread. If the textile is very weak, then a support of similar material may be provided and stitched at points. The other method is to use similar cloth and pasting it to the original at the non-written side with the help of about a 20% solution of poly vinyl acetate in acetone. Velcro also may be used to fix the support.

Storage of Records and Manuscripts on Textiles

The storage of the conserved textiles poses another problem. Polymer tubes of larger diameter are chosen to roll the textiles on them. In the polymer tube, few holes can be made and the body may be covered with acid-free tissue paper. Inside the tubes, both para-di-chloro benzene and thymol can be kept in sachets and covered both sides with blocks of wood. The textile pieces may be then rolled over the tube interleaved with acid free tissue paper. The whole set up is then covered with polythene covers to avoid dust and moisture. It is always safer to provide only incandescent lamps, as tube lights will emit ultra violet radiation, which will decolourise the textile pieces. Fibre optic lighting will not degrade the fibres of textiles. Care is taken to avoid natural light not to fall on, the textiles manuscripts. It is better to air-condition the storage through out day and night, which will control most of the conservation problems. It is desirable to use nontoxic pest control in the stacking of archives or the storage and galleries in the future. Freeze-drying at -20 to -30°C and non-toxic pest control at low nitrogen atmosphere will keep them well.

Integrated pest management (IPM) is a strategy to avoid pests or control insects, moulds and vermin in archives, library and museum collections. The strategy minimizes the use of toxic materials and treatments through implementing the right preventive measures. When the preventive measures fail and insects are found in the collections, the applied chemical treatment should be safe for people, manuscripts and the environment.

PHOTOGRAPHS AND OTHER MODERN DOCUMENTS

Getting copies of the records is called duplication of records. From the middle of the 20th Century, there has been a substantial inflow of modem synthetic information technology materials, in the form of microfilm, microfiche, unitised jackets, audio-visual material and other computer out forms to the collection of archives. As is well known, microfilming has been found to be a very good aid for obtaining copies of documents as well as exchange of information between different archival agencies world over. The stability and durability of these modem archival materials with passage of time are still to be studied. But the laboratory evaluation and investigations have helped establishing their quality standards and deterring storage environment congenial to long life. The life of such materials starts from the quality of raw materials, preparing, processing, storage conditions, their inspection, methods of restoration etc. Almost all photographic materials, magnetic audio tapes and other allied computer out forms contain an active chemical suitably mounted on paper or film base. The active photo sound sensitive chemical gets modified with light or sound. Like the traditional records, these modem materials are also prone to suffer damage due to hot and humid climate.

Photographs

There are different types of photographs in an archives or allied institutions. Mainly black and white photographs were used in the earlier days and many black and white photographs and negatives are being preserved. The black and white photographs are made in papers mounted with photosensitive chemical compounds such as silver halides.

In those days photographic negatives were prepared on glasses. Presently negatives are prepared on cellulose acetate films. The photographs are printed on photographic papers. Modern digital photographs are printed on special print quality papers and also on plain papers.

The glass negatives get damaged due to water, abrasion etc. The negatives should be held at the edges only. When stored, negatives should not touch each other.

The photographs, if found damaged, a fresh negative should be prepared. In the print the damaged portions should be reconstructed and another negative is prepared and preserved. Photographs should be framed with mounts and glass. If water is splashed on photograph, it should be dried as such. Negatives should be put inside acid free paper covers and arranged inside cabinets and the temperature and humidity are controlled.

Diazaonium salts and other dye based coloured photographic materials are prone to fading and get disfigured due to storage at high temperatures and therefore need special storage care. One of the major causes of damage is the presence of dust and other atmospheric pollutants.

A photograph has a base with an emulsion on the base. Inside the emulsion are held the image-forming substances. This is true for the majority of types of photographs, be that negatives or positives. There will be techniques that has got more elements, such as binding layers or pigmented inter layers.

Glass was widely used as base for negatives in the 19th Century and well into the beginning of 20th Century. Any historical photographic collection will probably hold big amounts of glass plates. Glass has excellent properties as a photographic base; it is transparent and dimensional stable. However, it can easily break during handling, if stressed or hit. Regarding the chemical stability, a break down mechanism called glass disease or weeping of glass is promoted by high humidity. Alkali is washed out of the glass, leaving a whitish fog in the glass surface.

Plastics have been used for negative base, and movie film bases for about 100 years. The first plastic was nitrocellulose (also nitrate or celluloid). This plastic is deteriorating at high relative humidity and temperature, with the release of nitric gases. This gives a very heavy chain reaction of further film deterioration and just about corrosion of everything else nearby. The smell of nitric vapours in archives will be a warning of this. A totally decomposed nitrate film will crumble to dust. More dramatic is the danger of self ignition, if larger quantities of nitrate are kept together. Nitrate on fire is impossible to stop, the blaze being explosion-like. This is especially a problem for collections of film on spools, and large quantities of nitrate film should always be considered an explosive, and stored accordingly to this. Nitrate was in use until about 1950.

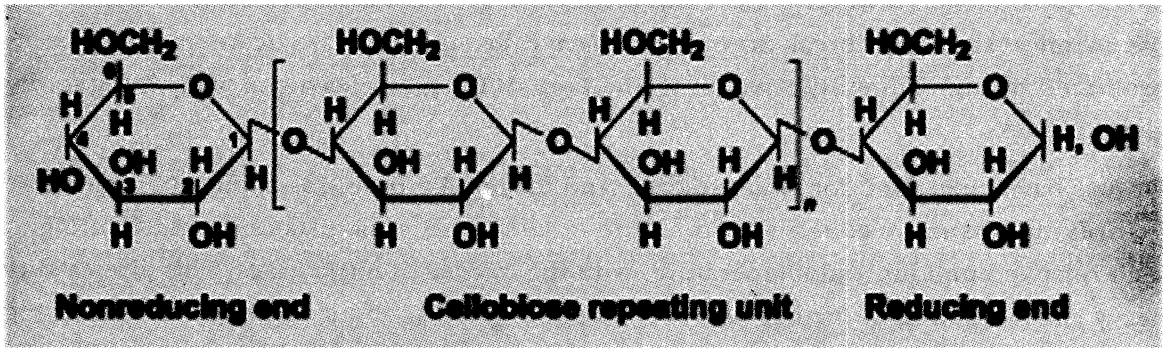
Cellulose acetate (safety film) was introduced in the 1940s, and took over from nitrate because it was not self-ignite. It has, however, over the years shown that acetate film is not stable. Again, a high relative humidity and/or temperature will accelerate a deterioration where acetic acid is released, which then will engage in a further break down. The result is 'the vinegar syndrome', the film base shrinks, and the emulsion falls out of the base. This is often found out because of a strong vinegar smell in the archives. Often acetate materials are divided into the early type "di-acetate" films and the more recent 'tri-acetate' films. Di-

acetate film is much less stable than tri-acetate, however, also tri-acetate film will deteriorate over time.

Synthetic polymers produced chiefly by reaction of dibasic acids with dihydric alcohols and used primarily as light, strong, weather-resistant resins. Today, polyester is regarded as the most stable plastic base material known today. For some products it is identified as ester. For any new photographic negative material, it should be emphasized to use polyester materials. Polyester is by the way also regarded as the most stable plastic material for storage enclosures.

Print Support Paper

Paper is one of the most common print support materials. As a support for positive images, it was introduced in 1840 and is still in use today.



Paper consists of cellulose fibre, which can be oxidised by atmospheric oxygen, causing deterioration. The products of oxidation can give rise to cracking of the molecular chains. The same occurs if the cellulose is exposed to acid or formaldehyde, which may have been added to the paper during manufacture. However, the same effect can come from air pollution and chemicals from fixing and development processes. A contemporary print product is the resin-coated photographic paper. The encapsulation of the paper with thin resin layers greatly reduce the development process time. However, as an archival material resin coated paper is less stable than the old-fashioned Fibre Base Paper.

Emulsions

Gelatin

The most common 20th Century emulsion binder is gelatin. It is a pure, clear adhesive extracted from animal bones, especially bones of calves and ox. Gelatin is very sensitive to

humidity and swells when it absorbs moisture. Strong alkalis or acids can break it down, originating from air pollution or bad housing materials. Since gelatin is an excellent nutrient for bacteria, photographic emulsions can be irreversibly damaged if stored in warm and humid surroundings. Historic collections might hold other photographic techniques, where albumen (made from hen's egg white) and collodium (nitro-cellulose dissolved in alcohol/ ether) also will be found used as emulsion binders.

The Image-forming Elements

By far the most photographic techniques are based on metallic silver as the image-forming substances. In modern colour films and prints organic dyes are used to create the images. Silver will be found as microscopic grains embedded in the gelatin layer. The more is silver in a local area, the darker it looks. Silver has great affinity to hydrogen sulphide (H_2S). Thus, black silver sulphide is easily formed. The attack manifests itself by the photographic plate or film becoming coated with a yellowish to reddish brown fog, which subsequently turns black. Early photographic techniques will often be more sensitive to sulphide attacks, as their silver grains are smaller, than at modern silver techniques. But beyond this, in recent years we have come to realise that the silver particles are broken down by other oxidizing gases. The underlying mechanisms have not yet been fully understood. The ensuing damage often resembles the tarnishing just described.

The organic dyes which are the image-forming element in colour photographs are split in tree layers, magenta, cyan and yellow layer. Together they form all possible colours in a colour image. Photographic dyes are damaged when exposed to heat, moisture or light. The rather complex dye molecules are broken down to colourless substances, while the colours fade away. Some techniques, as Ilfochrome, are more stable than others. Generally speaking new colour photographs will be more stable than older ones. However, no colour photograph will be as stable as a well-processed black-and-white photograph.

What Deteriorates Photographs?

Bad Manufacturing

While photographic paper and gelatin almost always are of a very high quality, much of the deterioration now observed in our archives originates from the use of other not-so-stable materials in the manufacturing.

Examples are the use of unstable base materials, as nitrate and acetate. Also the early colour photographs might consist of very unstable dyes. The early resin coated-papers were especially vulnerable to light.

Bad Processing

But even with stable products it is possible to end up with unstable products. By poor processing either the chemical reactions are not done through-out (as under-fixing silver photographs), or chemical residues are left in the photographic emulsion because of poor washing. Both will be the cause of brown/dark discolouring of silver images.

An Incorrect Climate (High Temperature and/or RH)

Standard organizations such as the American National Standard Institute (ANSI) or the International Standards Organization (ISO) has outlined storage climates sufficient for different photographic materials. The general pattern are, that the higher the temperature, the faster the speed of chemical reactions (as e.g. deterioration mechanisms). Regarding the relative humidity (RH), many types of deteriorations are moisture dependent, where a high relative humidity will start and accelerate decay. Also a very dry climate could cause deterioration, all though these problems will be physical ones such as brittleness, wrinkling.

The warning signs of unsuitable climate are many. Most of the times occurrence of the various chemical deterioration mechanisms already described will alert that the climate is unsuitable. In the tropics, the problems will often be a too high temperature combined with a very humid climate. In negative collections, warning will be the smell of nitric or acetic acid. When single negatives are examined, the base will be brittle and discoloured (nitrate), or buckled with air bubbles under the emulsion (acetate). Glass plates with glass sickness will be greasy, possibly with a white fog and a loose emulsion. Prints or negatives kept in plastic enclosures in a humid very climate might stick to the enclosure, causing great damage to the image. The most obvious warning of a too warm and humid climate is the presence of fungus and mould. Both the paper and the gelatin will be great nutrient for microforms, together with especially a high relative humidity. The same goes for the presence of insects.

In a very dry climate such as desert regions, paper prints will experience severe curling. And glass plate emulsions might loosen from the glass base.

For black and white (b & w) materials an adequate climate is considered being 20°C or below, together with a relative humidity between 20-50%. For colour materials the relative humidity recommendations are the same, but the storage temperature is recommended as low as max 2°C. This is very strict guidelines, almost impossible to follow without air-conditioning anywhere in the world.

So for the intention of keeping photographs for extended-term storage, efforts must be made to lower the relative humidity, and for colour photographs also the temperature. There are several approaches to this, simple as more advanced. If choosing advanced air-conditioned systems, it is very important that the system actually will be maintained, and that one can rely on a constant and uninterrupted power supply.

Different Methods for Controlling a Climate

The local placement of the archives in a house can, to a limit, give some control of the climate, especially the daily cycles. As the indoor climate will reflect the outdoors, it should be avoided to place the archives to near the biggest 'radiator' - the sun. Avoid placing an archive directly under a roof, or directly to the most-sunny side of the outer walls. Especially direct sun through a window should be avoided. As the building will buffer the relative humidity more or less, an archive room in the middle of a building, with no outer walls will be a good start.

Desiccants

A desiccant is a substance that absorbs or adsorbs water. It is most commonly used to remove humidity that would normally degrade or even destroy products sensitive to moisture. Silica gel, calcium sulphate, montmorillonite clay, and molecular sieves are commonly used as desiccants.

The use of various kinds of desiccants can be a good low-tech solution for keeping the relative humidity down. For small confined spaces like boxes or drawers silica-gel with blue indicator (could be an option, however, it should be noted that the silica-gel must be regenerated when exhausted by heating in an oven to drive out the water). It is possible to get silica-gel types embedded in paper or polyethylene. Paper is, by the way, an excellent humidity buffer. In archives with big bulks of paper the humidity could be kept quite stable by this, although not lowered. If silica-gel is used in larger spaces, the space must be somewhat sealed, because the inflow of moisture from the outside will exhaust the silica-gel too quick.

Air condition should only be used in tropical areas if the system also de-humidify together with the cooling. Because of the temperature dependencies of relative humidity of air, humid and warm air will soon reach 100% relative humidity when cooled down, that is: unless de-humidified also. Actually it is better not to air-condition at all, than only to cool the air. If there is regular power failures in the area, the climate will cycle too much because of the on-off switching of the air-conditioning. Air-conditioning is not always the best idea.

Cold Storage

For smaller collections, especially collections of unstable materials as colour slides or negatives, it can be a solution to use an ordinary commercial deep-freezer as storage area. As relative humidity will be almost 100% in a freezer, different systems are invented to keep photographs cool and at a moderate relative humidity. This can be plastic bag enclosures with desiccants, or the use of slightly heated inner boxes.

Pollutants

Many unwanted substances are constantly emitted from building materials, furniture, storage materials, and from some photographic materials themselves. Some of these substances can have a deteriorating effect of photographs, in high concentrations.

Silver images are especially vulnerable to sulphur-containing pollutants. Therefore sources of sulphur should be eliminated in archives. These sources can be fresh oil-paints, natural textiles as wool, carpets, and rubber. From outside sulphur pollution can originate from car exhaust fumes, and burning of oil. Organic acids and formaldehyde will emit from wood and wood board products, and will attack gelatin and paper in photographs. Also acetate film is vulnerable to organic acid, as this triggers the vinegar syndrome, with more emission of acetic acid from the film themselves. Nitric vapours will cause a heavy deterioration of photographs. Often the source of nitric pollution is the photographic material themselves, while cellulose nitrate film materials should be stored separately from other photographs. In collections of historic photographs, this also goes for collodium materials, both plates and prints. Nitric vapours can also emit from cellulose nitrate used as adhesive or lacquer on old boxes or furniture, and from car exhaust fumes from the outside. Peroxides are especially a great concern for photographic silver images, such as resin-coated prints, negatives and microfilms. Peroxides are emitted from fresh paint, and from bad storage enclosures. One warning sign of peroxide attack is the formation of red spots in the emulsion of microfilms, the so-called blemishes.

Storage Materials

Materials used for enclosures must especially be inert, as they are in direct contact with the photographs, and will therefore be a main factor of the possible deterioration of the photographs. As for the storage climate, there are standards regarding the properties of a good storage enclosure for photographic materials. The outlines of these are:

- That the materials used for an enclosure must be chemically inert
- Must be free of acids, sulphur and peroxides and have a pH around neutral (pH 7)
- Should not be able to do physical harm on the photographs

There are mainly two materials used for photographic enclosures: plastics and paper. The above criteria goes for both types, however, there is off course differences in their properties.

Plastics

Types of suitable plastics are high density polyethylene, polypropylene, and polyester. The above criteria rules out plastic as poly vinyl chloride (PVC), unfortunately this sort is very often used as an enclosure material anyway. PVC holds a large amount of plasticizer, which will bleed out during the ageing of the PVC. Common for plastic enclosures are that they are very diffusion tight, while for example acetic acid from degraded acetate negatives gets trapped, causing extra heavy harm. Also the phenomenon ferrotyping; the photographic emulsion sticking to the plastic sleeve, is a risk when using plastic enclosures, especially when the climate is very humid.

Paper consists mainly of cellulose fibres from plants, an adhesive, and some fill-out material as clay or chalk. The best quality cellulose for archival enclosures is from pure cotton fibres. Care should be taken with paper made of wood-pulp, as cheap ground wood-based paper will hold lignin, a substance which makes the paper acid over time. Also the glue used for holding an enclosure together should meet the above requirements; therefore rubber glue should for example be avoided. There is an envelope design which requires no glue at all, as the four-flaps-envelope. Also the glassine type of paper (a nearly transparent, resilient glazed paper resistant to the passage of air and grease) made transparent should be avoided, because of its acid content.

Despite of the disadvantage of paper; that you can't see through it, it is better to use paper rather than plastic enclosures because of the risk of the emulsion sticking to the plastic, and because of the much higher permeability of paper. This risk is especially high under tropical conditions.

Damages from bad storage materials on silver images will show as either blemishes (peroxides from non-archival paper), or fading of the image, the silver image becoming faintly yellowish. Also the so-called silver-mirroring can often be directly related to bad enclosures, such as the glue at the edge of an envelope. In a very severe acid attacks, the paper base and the gelatin will also be brittle, and probably discoloured (yellow-brown). Finally, all other items that very well might damage photographs should be removed. This can be item as rusty paper clips, or rubber bands.

Light

When exhibiting photographs, an extra deterioration factor, light radiation, should be considered. Light is energy, while it will be able to break down molecular bonds in the photographic materials. Where silver images are considered quite light stable, the organic dyes in colour photographs generally are not. This will result in fading of the image, often the yellow areas first giving the image a bluish tint.

Also organic materials as gelatin and cellulose can be deteriorated when exposed to large amounts of light, and especially modern prints coated with plastic layers might experience problems, such as cracks and yellowing. The basic rules for mitigating light induced damage are:

1. **Lowering the UV-radiation**
   Therefore direct sun light should be avoided, curtains should be provided for the windows.

2. **Low Light Levels**
   Not more than 50 lux for fragile materials, and 300-400 lux the most for other materials.

3. **Limit the Exposure Time**
   As light deterioration is accumulated, it is not recommended to exhibit photographs for unlimited time.

Biological Attacks

A relative humidity above 75% will promote the growth of fungi and mould. As the fungal spores are everywhere, this growth will always occur. The damage caused is irreversible. The only sure method to prevent micro organic growth is to maintain a moderate relative humidity. However, if this is not possible, it seems that some mitigation can be gained by

circulating air in the archives, e.g. with a fan. Micro-organisms often grow at places with very little air movement, as behind cabinets, shelves, and boxes. Surveys should be done quite regularly in very humid regions, for detecting growth of fungus or mould. Insects will especially be a danger for paper, such as silverfish, bookworms and termites. The warning signs are quite obvious, such as parts of the photographs simply is eaten away. As for the microorganisms, high temperature and relative humidity will be good living conditions for insects, while air condition to some extent can lower the risk of attacks. However, a very effective and basic preventive method is good housekeeping, as removal of dust will remove food and hide-places for the insects. Mechanical prevention as nets in front of windows and air-inlets will also stop some insects. If fumigation or extermination with insecticide is considered necessary, it must be emphasized to try to limit the use of insecticides, so the treatment goes specific towards the species of insects found in the archive. This gives the best effect, and the lowest risk of creating a resistance in the insects. If there is a problem in an archive it is therefore important to collect insects and get the species identified, and deliver this information to the pest control company which is in contract with the archives etc.

Besides this, great care should always be taken with fumigation and use of insecticides, as they will migrate from the archival materials to the users, when handling the materials. This might not be a problem for the one-time users, but for staff working everyday in an archive the exposure to poison can be quite high.

Preservation Strategy

As photographic collections often hold vast amounts of materials, the right preservation strategy is not single items conservation as much as it is preventive conservation actions, being beneficial for the lot. Maintaining a moderate, suitable climate in the archive together with the use of proper housing materials are the main factors to delay deterioration. Then, it is important to survey the collection on a regular basis, to identify outbreak of deterioration and finding the source. If photographs are deteriorated, action can then be taken to either conserve the material or to preserve the image by other means. Methods besides traditional conservation can be making 1:1 duplicates, microfilms, or possible digital work copies.

Microfilms

Silver halide emulsion used for microfilms is hygroscopic and absorbs moisture. It becomes soft and expands when the relative humidity is high. Film base also absorbs moisture but

to a lesser degree than the emulsion. This differential rate of expansion in the two important constituents results in damage. Further high humidity and temperature accelerate the growth of microorganisms and spots on films are quite a common phenomenon.

First generation microfilms are prepared from the original records. A copy is prepared. The master microfilm and copy are stored separately. From the negative only positives or copies may be made.

Air-conditioning of the storage area where photo archives, audio-visual materials etc., are kept is an essential need. If temperature is 14±2°C and relative humidity is 35±5%, they provide ideal storage environment. However, obtaining such lower limits of temperature in tropical climate where temperature gradient is much higher and increases the cost of operation of the air-conditioning plant.

An important aspect, which needs the attention for keeping these modem media is the storage containers used for keeping varied storage formats, while paper albums are for storing photo-prints and negatives of assorted sizes metallic, cardboard or plastic container are used for keeping microfilms. The negatives can be digitised and preserved.

Important guidelines are:

1. Acid free and lint free boards should be used.
2. Adhesive used should be of long-standing quality.
3. The containers should be of non-corrosive and non-staining materials.
4. It is necessary that positive and negative materials be kept separately.

Floppy Disks

Nowadays computer outputs are used in archives. The floppy disks should be stored properly. The following guidelines should be followed:

1. Floppy disks should never be exposed to direct sunlight.
2. The relative humidity should be around 30 %.
3. Since the floppy disks are magnetic in nature, telephone, x-ray equipment, motor generators should not be inside the storage.
4. The disks should not be bent.
5. They should be stored in separately indexed covers.
6. In case, there is no air-conditioned hall, silica gel may be used to absorb moisture where the floppy records are very fragile.

CD-ROM

CD-ROM stands for compact disk read only memory. This also comes in the form of Optical Disk. It can be used for storing audio, video or other software. This is portable. This gives the facility of storing huge volumes of data in a single disk. This disk can be used only to read or retrieve data. This cannot be used to write data once it is written. Recordable and re-recordable CDs are available nowadays. The surface where the reading of the CD is done should be free from dust, grease and scratches. The surface should never be touched. This is also necessary to store it within the CD case.

Compact Disks (CDs) have many advantages. Researchers search speedily through large quantities of documents on CDs, while protecting the original materials from excessive handling. An inexpensive distribution tool, CDs hold large quantities of data in a small space. During playing, no contact occurs between the playback device and the sound carrier so wear is minimized. Many CDs incorporate an Error Detection and Correction (EDAC) system that allows reconstruction of digital data when small errors or losses occur, making perfect copying possible. Since CDs vary little over time (until they fail), they may be duplicated without any generational loss of information.

CD's Life Expectancies

CDs are complex laminate structures vulnerable to damage by light, humidity, temperature mishandling and pressure. Since CD information is stored in blocks of data with EDAC correcting codes, it is not easy to determine when a CD is about to fail. CDs can be destroyed in a few minutes through poor handling or damaged from a few hours of being stored outside of their jewel cases.

Storage or handling that would not destroy tape or paper, such as bending, pressure, or light exposure, can destroy a CD. Don't count on CDs to last many decades because the poly carbonate substrate used on most CDs has a shorter life than paper or film. Few companies warranty their disks for more than a decade. Don't expect CD playback equipment for today's CDs to be available in 20 years, so equipment (and where appropriate, software) maintenance is essential. Don't dispose of your paper or film originals when using CDs for access copies.

Most CDs fail because of:

1 Physical stress leading to delamination, warping, and/or improper tracking.

2 Dirt or grit scratching media and leading to losses of information.

3 Yellowing of the plastic or light recording layer.

4 Low reflectivity due to oxidation of the aluminum layer (also known as laser rot).

5 Natural aging.

Standard CD Construction

Many CDs include a lacquer for durability, a reflective layer (usually aluminium; sometimes more stable gold), dyes (most frequently organic), and a substrate (often polycarbonate plastic, sometimes metal or etched glass) onto which the signals are etched by laser light. A marking agent, such as ink or an ink printed label may be placed on the CD. Many of these materials, particularly the substrate, vary over time and by manufacturer.

There are many CD technologies. The following are some of the most common types:

Write-Once Read-Many Times (WORM) format CDs are standard CDs commercially produced that may contain text, images, video, software, or sound. Compact-Disc-Digital Audio (CD-DA) is almost identical to standard WORM format CDs. CD-DAs are produced commercially for the popular music market.

1. Recordable Compact Discs (CD-R) are WORM format CDs that are produced one-by-one non-commercially by a recording disc drive. CD-Rs are playable on standard CD-DA or CD-ROM players.

2. Rewritable CDs can be erased and used again like magnetic media. Available in 90 mm and 130 mm digital optical formats, rewritable CDs require special players. Rewritable CDs use two separate technologies:

    a. Magnetic-Optical Rewritable CD-MO uses heat and magnetic fields to write the CD. Non-standard CD-MO players use polarized laser beams that indicate the magnetic orientation of each spot.

    b. Phase Change CDs use laser heat to reflectivity of the recorded section.

Evaluation of CD Materials

Look for CDs with a scratch resistant lacquer for durability, a gold reflector layer. Thalocyamine dyes, and a stable glass substrate. For these disks, manufacturers quote life expectancies equivalent to paper and microfilm records; however, testing data is incomplete. Don't use CDs made with cyamine dyes because they are less light stable.

Environment

1. Store and use CDs at 10-20 °C (50-68°F) and 40-50 % RH, away from sudden changes in temperature and relative humidity. Poor temperature and humidity in CD storage and usage spaces may lead to warping of the substrate and a resulting lack of CD flatness. CDs that aren't flat won't track, making them unplayable.
2. Store CDs in dark storage. Ultraviolet light, including sunlight, can cause the polycarbonate substrate or the scratch-resistant layer to darken, leading to player misreading and mistracking.
3. Store CDs in an air-conditioned space because polycarbonate substrates can absorb moisture and react to heat. These reactions in the substrate or the reflective layer can make the CDs unplayable.
4. Don't store CDs near heat sources, including the heat of ultraviolet light. Heat can cause the different layers of the CD to delaminate or can cause birefringence, the double bending of light. This optical effect leads to reduced signal strength and disc errors or failure.
5. Don't store CDs in high humidity because this may cause oxidation of the reflective layer.

Housing CDs

House CDs in jewel cases with an internal tray and hub to hold the CD in position. If it is software, the CD may be housed in paper sleeves. Polystyrene jewel cases are the preferred storage system, although paper or board housing that is certifiably acid-free is acceptable as long as it is boxed vertically in archival boxes.

Replace the jewel cases what have no internal tray or hub with ones that do. An ink-printed paper label may be fitted under the tray for reading through the jewel case cover. For long-term storage, remove any booklets, notes, or un-adhered printed paper labels in the jewel case because they may be acidic. Have these items to the CD catalogue number and house them in archival storage.

1. Don't use cracked or broken jewel cases; replace them with new ones.
2. Don't house CDs next to acidic paper, inks, or adhesive.
3. Don't mark CDs with adhesive labels, ink, graphite, or similar materials; instead, label their jewel cases.

4. Don't label CDs by writing directly upon either the CD or a pressure sensitive label that is already applied to the CD surface because this may lead to de-lamination.
5. Don't pull pressure sensitive tape or labels off CDs because this may lead to de-lamination.

Handling and Use

1. Wear clean, white cotton (lint-free) gloves when handling CDs.
2. Hold the CD by the edges. Never flex, bend, or place pressure on a CD because this may cause delamination.
3. Hand-deliver original CDs rather than shipping them.
4. Write on CD labels before applying them. If the CD is already labeled, add additional labeling to the CD housing.
5. Avoid rough handling of CDs. CDs play from the center to the outer edge. When a tracking problem exists, such as a player skipping sections of a CD, it is usually due to warping, scratches, or delamination from improper handling.
6. Don't use the only copy of a CD created for long-term data storage.
7. Don't mark, label, or emboss a CD.
8. Don't use UPS, the mail, or public carriers to transport sole copy CDs.
9. Don't expose recordable CDs to light because it may lead to information loss.
10. Don't press down upon or scratch CDs.

Cleaning CDs

1. Clean CDs only when absolutely necessary.
2. Use compressed air for cleaning.
3. If compressed air doesn't work, dampen a cloth with distilled water and brush the CD to the outer edge from the center of the disc. Never use solvents.
4. Don't rub CDs because you may embed dirt in them.
5. Don't brush CDs in a circular movement because it may cause data error.

Reformatting CDs

1. Develop a reformatting schedule for migrating or remastering CD data.
2. Test CDs regularly so you know when to implement the plan.
3. Ensure that the contractor uses an EDAC technology system when copying CDs. EDAC incorporates mathematical formulae that ensure redundancy as those small sections of digital data can be reconstructed, if lost or damaged. EDAC systems require almost 25% additional storage space on your new copy CD. Copying CDs is a slow and expensive job.
4. Set up an inspection process for CDs remastered or recopied prior to payment for the work.
5. Don't assume that you can tell when a CD is failing by looking at it; instead test it to see how close the CD is to exceeding its EDAC limits.
6. Don't use CDs for long-term storage of data without setting up a data migration and remastering schedule.
7. Don't assume that reformatting CDs will be cheap.
8. Don't assume that you don't need to inspect copied CDs for completeness and accuracy.

Hard Disks

Hard disk is a storage system, which is necessary to a computer to work with. It is not portable. It should be free from strong magnetic fields. Viruses can affect this and therefore installing anti viral software in the hard disk should prevent it.

CLAY TABLETS AND POTSHERDS

Inscription on Potsherd

In ancient times writing was done on potsherds and clay tablets. The latter were made of clean-washed, smooth clay. While still wet, the clay had wedge-shaped letters (now called cuneiform from Latin word, *cuneus*, meaning wedge) imprinted on it with a stylus, and then was kiln fired or sun dried. Tablets were made of various shapes - cone-shaped, drum-shaped and flat. They were often placed in a clay envelop. Vast quantities of these have been excavated in the Near East, of which about a half million are yet to be read. It is estimated that 99 percent of the Babylonian tablets have yet to be dug. The oldest ones go back to 3000 B.C. They are practically imperishable; fire only hardens them more. Personal and business letters, legal documents, books, and communications between rulers are represented

Damages in Clay Tablets

Clay tablets mostly found are sun-dried. They pose a lot of problems of conservation. Sun-dried clay tablets whither, crumble due to salt action. The letters found are also lost in due course of time. Unless supported with supporting materials, the handling will be very difficult.

Conservation

Clay tablets are fragile, having only been sun baked and are often contaminated with salt. Scholars need to handle tablets to decipher the text. The collection is very frequently consulted and consequently undergoes heavy handling. A conservation treatment was developed in the 19th Century to impart structural strength and allow the tablets to be handled without resultant damage. The treatment was introduced into the British Museum in the 1950s and consisted of heating the tablets slowly to 740°C, cooling, and then desalinating by immersion in running water. No attempt was made to characterize the clays, or to establish whether the same firing cycle would be appropriate for groups of tablets from different sites.

In the case of fired tablets, the problem is less. The buried tablets or pot-sherds absorb the salt in the soil and embedded with salty encrustation. If the salt is water soluble, it is removed by soaking the tablet in distilled water by dissolution. In the case of large tablets or potsherds, poulticing can be done with the help of paper pulp to remove the soluble salts.

STONE INSCRIPTIONS

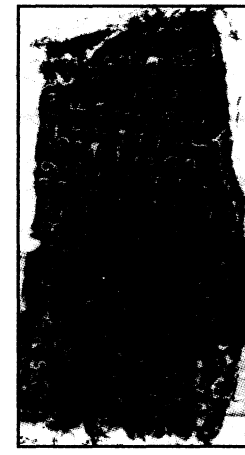
Stone inscriptions are the earliest records available through out the globe. As stone is a durable material this was chosen for recording the events of the past. Stone inscriptions exist for quite a long time. Besides this inscriptions on baked bricks and terracotta manuscripts are also found. Stone tablets, terracotta manuscripts, bricks etc., are preserved in the museums and epigraphical institutions. The preservation of stone inscriptions is the duty of the epigraphists, archaeologists, curators or conservators in the concerned institutions. But problem of preservation of the estampaged paper material is an archival one. The stone tablets might have been in a temple or in a forest. The inscribed matter is copied in paper by the technique called *estampaging.*

Technique of Copying

Stone inscriptions are copied by a technique called *estampaging.* The stone inscription is cleaned with water. Large sized white paper is made wet and placed over the face of the inscription and pressed well by striking with a bent brush. Paper gets into the groves of the inscribed letters. Some times two or three layers of paper might be required as the striking of the paper with brush may damage the paper and the torn paper might not serve the purpose. Then carbon ink is applied to a semicircular inkpad and the ink is transferred to the paper laid on the stone inscription by rolling. Except the portions, which are pressed into the grooves of the inscribed letters all the plain portions will take the ink. The inscribed portions will appear white and the other portions will appear black. This paper with the inscription is to be preserved.

Preservation of the Estampaged Paper

The estampaged paper is a very ordinary map litho paper, which is used in printing. They are prone to insect attack and microbial plant growth. High humidity, temperature, dust, acidity etc., will affect the estampaged paper. The conservation of the estampaged papers is similar to that of paper. The estampaged matter may also be photographed. The digitised records can be stored in a CD and printed when ever required.

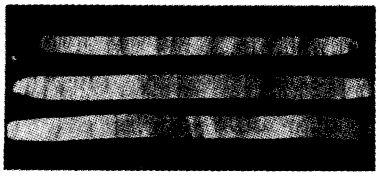


Estampaged Paper

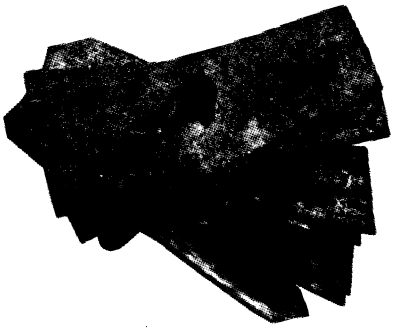
If the stone inscriptions are affected by salt action, they may be kept immersed in distilled water until the soluble salts are removed. If the inscriptions are on the walls, then the soluble salts will be removed by paper pulp treatment using distilled water.

RECORDS AND MANUSCRIPTS ON METALS

Man has used metals to record the happenings after he found difficult to carry the stone carved records from one place to the other. Different metals were used by man for this purpose. Among them gold, copper, bronze, brass etc., found place as manuscripts.



Gold Leaf Manuscripts



Copper Plates

Records and Manuscripts on Gold-leaves

Gold has been used as the support material for manuscripts in the physical form of strips. Gold is a noble metal. If gold is pure, it does not corrode even if gold manuscripts are found buried under the earth for a long time. Red gold, white gold, electrum are some of the important alloys of gold. Gold is malleable and ductile; it is flexible. When such alloyed gold manuscripts are exposed to corrosive atmosphere, the baser metals corrode first and leached out to the surface resulting in the surface enrichment of gold. For example, copper in a gold alloy corrodes first and the corrosion products cover the whole object making it to look like copper. When the corrosion products are removed, gold appears to be bright. Gold manuscripts, which are in contact with copper also, appear greenish-blue because of the corrosion products of copper. Such manuscripts are treated with alkaline sodium potassium tartrate and the original appearance is regained. Gold manuscripts, which were buried in lime deposits, were found to be covered with calcareous materials. Such manuscripts are immersed in a 1% solution of nitric acid, which removes the calcareous materials.

The dirt on gold manuscripts can be easily removed by a mild detergent like Laboclean, Laboline, Extran etc. Cleaning with an ultrasonic cleaner with a detergent solution cleans the manuscripts for a few minutes in a 2% caustic soda solution. Buried gold manuscripts sometimes appear purplish-red in colour giving an aesthetic look. It is a valuable patina worth preserving but it is easily rubbed off.

Records and Manuscripts on Copper

Beginning with Berthelot, several investigators-Rosenberg, Fink, Polushkin, Collins, Caley, Plenderleith and Rutherford J. Gettens, have described the chemical nature of the layered structure on the surface of ancient manuscripts of copper and its alloys and have also

suggested chemical and/or electrochemical reaction mechanisms to explain the formation of several mineral products compacted on them. Some of the corrosion products on the copper antiquities are red cuprous oxide (Cu_2O), black cupric oxide (CuO), greenish blue malachite [$CuCO_3.Cu(OH)_2$], blackish green *atacamite* and *paratacamite* ($Cu_2(OH)_3Cl$), azurite [2CuCO3.$Cu(OH)_2$], *Chalcopyrite* [$CuFeS_2$], etc. The corrosion that occurs on the alloys of copper such as bronze, brass, etc., is dominated by the chemistry of copper, and the major elements present, in the alloy. The main corrosion phenomenon encountered in bronzes and allied materials is termed bronze disease. Bronze disease is a form of pitting corrosion where, the metal constituent(s) present in the alloy being at the lower side of the electromotive series with respect to the major metal copper is actively dissolved by the corrosive agents and the corrosion products get deposited in the pitted points.

Patina Formation

Under conducive temperature in the presence of atmospheric air copper reacts with oxygen, an oxidant, to form a layer of cuprous oxide, Cu_2O. The object becomes covered with the familiar brown patina of bronzes, which constitutes a protective layer conforming to the original contours of the object. This copper (I) oxide may subsequently be oxidised to form copper (II) compounds, which are characterised by blue-green colour. Basic copper nitrates, sulphates, carbonates are the end products of the continued combined effects of air, water (moisture), carbon di oxide and pollutants like oxides of nitrogen and sulphur on copper and its alloys. Such patina once formed is stable for centuries and is called *edel patina*, which imparts an aesthetic beauty to the artifacts especially to copper or bronze or brass manuscripts.

Conservation of Metal Sheets

The two main objectives of conservation of metals are,

1. Removal of corrosion products and
2. Arresting further corrosion.

Removal of Corrosion Products

The deleterious corrosion products on metallic manuscripts should be thoroughly removed in order to prevent further corrosion of the manuscripts. The removal of corrosion products can be effected either by a) Physical, b) Chemical, c) Electrochemical/ electrolytic method or d) by the combination of one or more of the above methods.

A. Physical Method

The corrosion products on metals along with the siliceous materials can conveniently be removed physically by simple mechanical tools such as pin, scalpel, chisel, hammer, mechanically operated vibro-tool, etc. The areas exposed after the unwanted corrosion products thus removed are given a final rub with fine emery paper to bring out the inner patina layer to relief adding aesthetic beauty to the manuscripts for certain patina layer to relief adding aesthetic beauty to the manuscripts for certain patina can also act as a protective coat. Mechanical means of removing deposits have the advantage over chemical means in that the former methods do not introduce or leave behind any additional chemicals or products of chemical changes on the metal manuscripts. Air abrasion may also be carried out. Laser beams are also used to remove the unwanted accretions.

Ultrasonic method can be used to remove the extraneous siliceous matter by immersing the manuscripts in a detergent solution contained in an ultrasonic cleaner. Vibro-tool may also be used. However this technique calls for extreme care, for lack of it may damage the finer workmanship of the manuscripts. Airbrasive can also be of use.

B. Chemical Method

Usually chemicals, which can dissolve or form soluble complex with the corrosion products, are used to remove the deleterious materials from the manuscripts. Only mild chemicals and very dilute solutions are used to remove the corrosion products without affecting the metal beneath. If chlorides are present in bronze antiquities, the antiquities are soaked for few weeks in an aqueous solution of sodium sesque carbonate (equal proportions of sodium carbonate and bicarbonate), the completeness of removal of the corrosion products is indicted by the carbonate solution acquiring the faintest blue tinge. This procedure converts into oxides and / or to other harmless metal chlorides yet protective corrosive products and thereby the copper based manuscripts are protected and preserved.

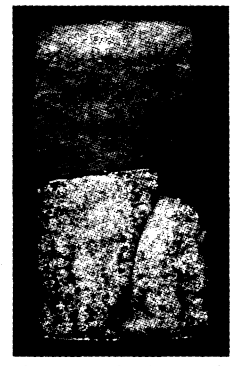
Buried copper-based manuscripts coated with a heavy white deposits of calcareous materials such as calcium carbonate and magnesium carbonate are soaked for about a week in 5% aqueous sodium hexa meta phosphate in which the calcareous deposits are soluble.

The bronze diseased bronze or brass or copper manuscripts may be treated with alkaline Rochelle salt solution (15 gms of Rochelle salt i.e. sodium potassium tartrate, 5 gms of sodium hydroxide and 80 ml of distilled water). This removes completely the corrosion products of copper and the oxide layer is exposed. Red copper (II) oxide is removed by

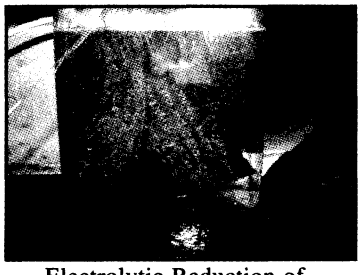
treating with a 10% citric acid solution, but the surface is found to be rough because of pitting of the metal by citric acid. 10% ammonia is used to remove the copper corrosion products as ammonia forms a complex with the copper chloride. A 5% EDTA solution is used to remove corrosion products. The black silver sulphide (Tarnish) and the lavender silver chloride are removed by 10% formic acid and 10% ammonia alternatively. The debased silver manuscripts look like copper as they are covered with corrosion products of copper. They are first treated as if they are copper plate grants manuscripts.

Electrochemical /Electrolytic Reduction

The electrochemical reduction involves the reduction of the corrosion products by nascent hydrogen evolved by the action of 10% sodium hydroxide on zinc granules/powder on the affected spots. The corrosion (oxidation) of metallic manuscripts is usually an electrolytic process. Reduction is usually carried out in an electrolytic cell keeping the metal manuscripts as the cathode with two strips of iron gauze suspended on either side of the object or a cylinder of the same material enclosing the object all round, as the anode in a 5% aqueous sodium hydroxide/sodium carbonate/ acetic acid or formic acid electrolytic bath. Current is passed from a direct current supply from a 1-50 volts source and an optimum density (2 amps per square foot with respect to cathodic object) for a few to several hours, depending on the thickness of the encrustation. The corrosion products on the antiquity are reduced and removed by alternate brushing and washing until the hidden details are exposed with all its intrinsic artistic details. The photograph shows a treated and untreated portion of a copper plate grant.



Broken Metal Manuscript



Electrolytic Reduction of Copper Plates

Electrolytic Brushing

In the case of large sized, non-transportable copper based manuscripts (which cannot be easily shifted from the galleries/stores to the laboratory) a localised treatment of a slightly modified electrolytic method is resorted to, with good success. The metal object affected by spot corrosion is kept as the cathode. A steel rod with a sponge head moistened with 10% caustic soda solution is connected to a 12 volt direct current power supply and the

electrolyte impregnated sponge is pressed on the affected spot and the circuit completed. Electrolytic reduction takes place and the spots get reduced to the corresponding metal.

Intensive washing

Intensive washing is the last step but definitely not the least in importance in conservation of manuscripts; unless the treated metal manuscripts are washed completely free from the residual chemical(s) left behind on the manuscripts, they will once again react with metal and the corrosion cycle will be repeated again. Therefore, washing should be intensive and thorough in the final stages especially with methods involving chemical treatment. The last residual salts in the treated metal manuscripts are best eliminated by prolonged soaking of the manuscripts in distilled water or the process may be speeded up by using hot water. This process may be repeated to ensure complete removal of chemicals. Intensive washing technique with distilled water can be successfully done by alternate heating and cooling.

Arresting Corrosion

1. Stabilization of Highly Corroded Metal Manuscripts

In most of the excavated metal manuscripts, it is seen that the corrosion has proceeded to an extreme stage where very little metal is left intact. In such cases, manuscripts can best be conserved by stabilising the corrosion products formed. Spots of bronze disease formed over protective layer of patina may be mechanically removed. The pits found are then filled with a fine paste of silver oxide (in alcohol/water). Insoluble silver chloride thus formed seals off the underlying harmful effect of copper (II) chloride arresting further corrosion. Sodium sesque carbonate solution dissolves the copper (II) chloride (bronze disease) without affecting the copper (II) carbonate (protective patina). Zinc dust in place of silver oxide may be used effectively.

Therefore prolonged immersion of the *bronze-disease* affected manuscript in a solution of 10% sodium sesque carbonate removes the deleterious chlorides and stabilises the carbonate patina formed on copper based manuscripts.

Benzotriazole (BTA) in water or alcohol forms a complex with cupric chloride and oxides. This inhibition procedure can also be adopted to arrest further corrosion. Benzotriazole in water is

preferred to benzotriazole in alcohol in the cases of manuscripts with a thick layer of bronze disease as the former slowly but surely penetrates into the core of the metal-the evaporation of water mixture being slow compared to benzotriazole-alcohol treatment. This is the most effective method for the conservation of copper-based manuscripts affected with bronze-disease.

One of the methods of preventing *bronze disease* in manuscripts is to maintain the antiquity in a dry atmosphere (45-60% R.H.) and a temperature of 19±1°C. Under these conditions the spreading of further corrosion is arrested.

DIGITIZATION OF RECORDS AND MANUSCRIPTS

Getting copies of the records is called duplication of records. From the middle of the 20th Century, there has been a substantial inflow of modem synthetic information technology materials in the form of microfilm, microfiche, unitised jackets, audio-visual material and other computer out forms to the collection of archives. As is well known microfilming has been found to be a very good aid for obtaining copies of documents as well as exchange of information between different archival agencies world over. This is a very good system in which no faking can be done. Xeroxing is another facility available to duplicate copies. Computer is now playing a very important role in the duplication of records and in these cases the information is digitised. Cultural institutions such as museums, libraries, archives, and historical societies house remarkable collections of cultural artifacts. It is the responsibility of the staff working for those institutions to preserve, protect and provide responsible stewardship for the materials, and to the best of their ability, provide continued long-term access.

Advances in technology allow institutions to provide expanded access and education; however, there are important priorities that must be addressed prior to embarking on a digital conversion project. Digitization in an archival environment includes taking a physical manuscript or analog item, such as an art manuscript, a tape recording, a map, or correspondence, from a collection that is rare or unique, often extremely fragile, and taking photographs of the item, and transferring the photographs to a digital medium. The negatives or prints are scanned into digital format such as a JPEG (Joint Photographic Experts Group,1400 pixels) and even larger, TIFF (Tagged Image File Format, 2000 pixels) files (Library of Congress, 2000). Digital files are imported into, and managed with the use of software programmes. Digital files may be read, compressed, transferred and retrieved over computer networks then made accessible and viewed on computer monitors. The end product is determined by how well these functions are performed.

Governmental agencies, institutions of higher learning and the commercial and entertainment industries are fast developing technological infrastructures to accommodate the needed access on the Internet. The Internet has become the agora for research, teaching, expression, publication, and communication. Many, especially the younger generation, consult libraries and archives as a last resort. This must change if libraries and archives

want to continue as primary information providers. Cultural institutions are investing in digital projects for several reasons including; to provide access, to reduce over-handling of material in order to preserve it, and public relations to assist in promoting the collections and the institution. By creating digital surrogates of their collections, institutions continue to support the notion that there is value in the materials they house. Most digital conversion projects are driven in part by the institutions strategic goals. Unfortunately institutional goals are often in conflict with the necessary structure of an ideal digital conversion project. Resources are useless unless they are accessible. Therefore, if an institution is to embark on a digital conversion project, sufficient thought, planning, risk management, and correct infrastructure, both professionally and technologically, must go into the process or the project will fall short of the intended goals.

Advantages of Digitization

Digital imaging projects offer unique advantages. Information and content may be delivered directly to end-users, and can be retrieved remotely. Image quality can be quite good, and is often enhanced, with capabilities continuously improving. There is added advantage with the possibility of full-text searching, cross-collection indexing and newly designed user interfaces that allow for new uses of the material and content. Flexibility of the digital material is another advantage. Since the data is not fixed, as with paper or printed text, it is easy to reformat, edit and print. Moreover, the ability to provide a large number of users' access to unique or special collections' material (normally viewed only on-site) may be the most attractive feature of digital conversion projects. Online resources serve local, national and international needs. Increasing access by any means, specifically remotely, makes historical or literary research much easier. Allowing for a wider audience to view digital surrogates of primary material provides a great service and increased utility to the collection. There are no travel costs involved and this interaction may allow for the creation of new knowledge. Providing access to primary material can help to publicise the material to other departments and peers, and to demonstrate the importance of the collections. Profound changes in professional attitudes, private and public funding, availability of image reproductions, and electronic communication technologies have resulted in archaves, libraries and museums re-evaluating their target audience. The general education market is the new target audience, and the new method of providing information is through electronic media, most often through the World Wide Web. Digitization projects allow for extended data

recovery, enabling scholarship that was previously not possible with analog material. Computer enhancements, such as enhanced optical character recognition (OCR), allow for more in-depth analysis. But institutions need to realize that digital resources are institutional assets in their own right, and not merely surrogates of an analog manuscript; they must be managed, preserved and migrated over time. Participating in digitization projects, allow for professional development as staff gains new skills, knowledge and expertise while completing the project. An institution and its staff also become assets and may share expertise and lessons learned with other institutions. Not only does digitization provide added value to the resources; it may also breathe new life into older institutions. Another advantage of creating digital surrogates is, use of the surrogate reduces handling of the old or fragile material, hopefully extending the life of the original.

Disadvantages of Digitization

Required staff expertise and additional resources are often the greatest costs in digitization projects. Not only are large budget allocations needed to fund research and intellectual selection, but also time must be spent for feasibility assessments, training, and methodical prioritization of items or collections to be digitised. These requirements pull staff away from their regular workloads. Cataloging the new material adds additional base costs to the budget. Digital conversion projects require added levels of work not needed in traditional reformatting projects. Many institutions lack expertise and preparation must be well-planned. Digital conversion is not yet a form of preservation; which relies on long-term, stable media, which cannot be expected with today's technology. The only accepted long-term preservation media are durable acid-free paper or preservation microfilm. Access to successful digital surrogates often encourages people to wish to consult the original. This impacts staff in other ways with more calls, letters, and requests for publication or reproduction of the materials, and added reference service is necessary. High-quality surrogates must be created in order to satisfy the users' needs, or they will need to go back and consult the original. Financial costs are extremely high and cultural institutions usually operate with either flat or marginally increasing budgets. Operational environments must have fundraising and accountability. With such great costs of staff time and funding, the risk of loss, is very high. Another disadvantage of creating digital surrogates is that users are completely reliant on computers and stable Internet connections to view and retrieve the digital information. Depending on users' hardware and software capabilities access may be frustrating

because of the large variety of computer models, platforms, software, and hardware around the world. Ease of access to a digital collection leads to high expectations of end-users. There is a tendency to believe that everything is available online, that every piece of information is true and accurate, and that everything available online is free. Rarely do users understand or appreciate the scope of the collection and its relationship to other parts of the collection.

Selection of Collections

Institutions select collections for digitization based on specific goals. Each decision should be weighed against a cost and benefit analysis for the end users and the institution. Subject specialists such as archivists, librarians, curators (familiar with both the collection and how it is used) must be key decision-makers. Selection for digital conversion continues to work under the premise of access and ease of use, rather than physical deterioration. Digital conversion projects should be goal driven rather than technologically driven. Other institutions which has digitized also should be consulted on the pros and cons of the project to avoid the wastage of time and money. The selection may be based on the importance, usage and availability of funds and equipments.

Conclusion

Cultural institutions house rare and unique artifacts recording the history of humankind. Providing greater access to collections may bring together vast, disparate collections and may inspire new scholarly work. By prioritizing digital projects, allocating funds, and working together, cultural institutions provide added utility to collections. Advances in technology create new challenges and workloads, for staff and institutions, not present before. Part of the problem lies in the fact that currently there is no consensus regarding digital conversion or preservation of digital material. Professionals must work together to address the problems stemming from the fact that there are no set standards for preservation of digital material. Even after one has addressed the legal, ethical, technical, and professional issues surrounding digital conversion projects, what still needs to be addressed are the needs of the end-users. Providing access to digital collections in an unmediated environment creates continued challenges.

STORAGE AND CONSERVATION GUIDELINES

There is a natural tendency to relax conservation vigilance when the manuscripts are out of sight in storage or in vaults. The basic principle of storage is to keep the objects in a physically secured environment and yet to permit ready access for inspection before their removal to the galleries, storage or other locations.

Storage

Storage is very important in the preservation of archival materials and manuscripts. It is not sufficient if proper environment is available to the building, but there should be proper arrangements for storage and proper storage materials should be thought off and used. It is always better to consult the experts such as architects, engineers, conservation scientists etc., before the construction of the buildings for archives, libraries or museums.

1. The racks should be made of steel and painted and fixed away from the wall and at least 15 centimetres above the floor.
2. The racks should be adjustable and should facilitate the flow of air from one window to the other window at the other end.
3. The legs of the racks should have provision for trays to keep water or insecticides to avoid insect to reach the racks from the floor.
4. There should be provision to keep the records in the racks and remove them wherever necessary without difficulty.
5. There should be working space between the racks. There should be provision to vacuum clean the racks in the stack area or storage.
6. The wooden boards used to bundle the records should be bigger than the records and tied properly tight.
7. Iron needles, pins, hooks should be removed from the records when kept in the racks.
8. The records should be kept vertically so that the indexed boards are visible. In case of big records/maps they may be kept one over the other interleaving between them in shallow drawers.
9. A metal or wooden cabinet, such as those used for storing architectural drawings, is useful. All the above climate control issues apply.

10. Smoking and open fire should not be allowed inside the stack room as they are dangerous to the archival materials.
11. Food materials should never be allowed inside the stack room as they attract the rodents.
12. Displaying a board explaining what should be done and what should not be done will help the staff to take much care.
13. Periodical dusting of the stacks should be done.
14. Periodical fumigation of the records should be made.
15. Affected storage materials should be changed whenever required.
16. The stack area or the storage should have an air control system to prolong the age of the documents and materials.
17. Proper training facilities should be provided to the staff in the latest archival principles followed.
18. Proper discussions should be arranged between the conservation chemists and archivists or librarians. Archivists should participate in the seminars relevant to the conservation of archival materials and manuscripts.

Storage Devices

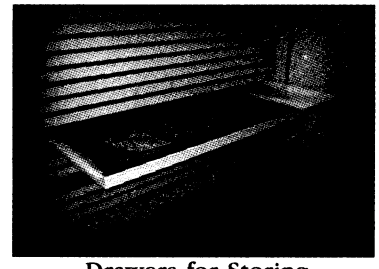
There are various storage devices and they are expected to meet the physical and environmental criteria intended for preserving the manuscripts against damages.

Shelving

Shelves may be constructed either by wood or preferably by metal free storage. Vertical slots may be designed for manuscripts. Boxes of different sizes may be made in acid free boards or higher polymers and rare manuscripts may be kept wrapped with acid-free tissue paper inside. This method will utilise all the spaces available in the shelves, when there is only a limited space. These boxes can be arranged one over the other.

Drawers and Cabinets

Drawers are used for manuscripts on textiles, maps and similar items, and also, when appropriately designed, for bark manuscripts, illustrated manuscripts. Interleaves of acid-free tissue papers are used.



Drawers for Storing Manuscripts

Sliding Screens

Sliding screens are very common for paintings and flat works and occasionally for decorative art, or arts, which can be suspended by appropriate hooks. Such system is economical of floor space and is efficient for examination and retrieval purposes. Maps, illustrated manuscripts on paper, etc., may be framed and kept stored in the sliding screens.

Compaction Devices

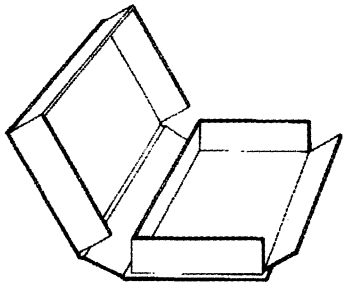
Compaction device is fairly recent in the museum world and answers in the requirements for more storage and less space. Compaction equipment is intended for permanent storage primarily. The compaction units are either electrically or manually operated. The manual type of compaction equipment is probably more useful for museum storage, as it is less likely to go wrong. In this type normally textiles are preserved. Rare manuscripts, illustrated manuscripts bundles, metal manuscripts etc., may be stored.

Vaults

Vaults and security storage areas are used for extremely valuable manuscripts, e.g. gold manuscripts, copper plate grants, etc.

Preparation of Book Cases

Old rare books are in need of some protection either in the racks or in the storage. Boxes such as book boxes, Solander boxes may be made and the books got protected.



Solander Box

A more or less elaborate book or document box invented by Dr. Daniel Charles Solander, a botanist, during his tenure at the British Museum (1773-1782). The Solander box, which is generally of a drop-back construction is made of wood, has dovetailed joints and a back shaped from a single piece of wood. The top and bottom are held in place by screws and glue. The box is secured by two spring catches fixed in the 'fore edge' frames near the head and tail. When properly constructed, the Solander box is very nearly dustproof and almost waterproof. The box, which can be made as elaborate as the maker desires, is generally covered in cloth. It is also now a days made using acid free or alkaline card board.

Conservation Guidelines

1. It is better to have teak wood but un-varnished racks to arrange the palm-leaf manuscripts. Un-varnished wood will be a puffer for the manuscripts as the wood will absorb moisture during the moist situation and dissipate moisture during hot season.

2. Palm-leaf manuscripts which are treated with citronella oil should not be stored in painted racks or almyrahs. The paint will be dissolved by the traces of citronella oil and paint sticks to the palm-leaf bundles.

3. When painted steel almyrahs or racks are used, they should be painted with non-corrosive paints. The bundles should never be kept directly on the painted surfaces. They should be arranged on hand-made acid-free boards kept in the rack/almyrah in such a way that they are stored not one over the other.

4. Storage areas should be maintained clean and the waste and condemned furniture should not be stacked in the storage.

5. Regular vacuum cleaning should be done to get rid off dust.

6. If open storage is maintained, the objects should be covered by sheets or bags.

7. In order to avoid wastage of space in the storage as well as to avoid dust, slotted angle shelves should be arranged with different sized boxes containing manuscripts to fit in the space available.

8. The R.H. and temperature should be maintained at the optimum level and it should be monitored regularly.

9. Light sensitive objects should always be kept closed by screens.

10. When scholars are allowed to study the reserve collection pencil only should be allowed for writing. Otherwise there is a likelihood of manuscripts being stained by ink.

11. Biocides should be used regularly to drive off insects and microorganisms. Before the advent of monsoon organic objects should be fumigated with thymol in other to avoid the growth of fungi and fogged with D.D.V.P. to avoid insect attack.

12. Smoking should never be allowed inside the storage area as it involves fire risk.
13. Open fire should never be used even in the form of lamps.
14. When objects are removed from higher shelves ladders should be used with care.
15. Manuscripts should never be kept near windows.
16. No manuscript should be directly placed on the floor. Some support should be provided, which should be acid proof.
17. It is better to have a small conservation laboratory attached to the storage to handle the little defects then and there which will avoid unnecessary transportation.
18. The lowest storage shelf of the stack should be at least 9 inches above the floor level.
19. There should be space between the wall and the stacks to avoid moisture transfer from the wall and to avoid insect attack and also to make inspection of the racks from the back.
20. The manuscripts should be well documented for their easy retrieval.
21. Electricity controls, fuse boxes etc., should be installed outside the room.
22. Inflammable materials like paints, chemicals etc., should be kept outside the storage room.
23. Open fire and smoking should be strictly prohibited inside the storage.
24. Displayed manuscripts should be well supported on a flat surface.
25. Light, relative humidity, dust, temperature should be controlled in the storage.
26. The manuscripts on display should be changed with other manuscripts to avoid fading.
27. The floor should be provided with carpet to avoid the dust from the visitors.
28. Wearing foot-wear may be avoided in the storage area.
29. Eating in the storage area should be avoided.
30. Annual checking of the manuscripts should be done regularly.

31. There should be a fumigation chamber to treat the affected manuscripts immediately.

32. Well padded trolleys should be used to transport the archival materials and manuscripts.

Storing CDs

1. Select storage systems that protect CDs from excessive or cycling heat and cold, ultraviolet light exposure, air pollution, and scratching by dust or handling.

2. Store CDs and other optical discs vertically within their jewel cases in slotted racks or boxes, unless the CDs are played on a regular (daily) basis. CDs being played regularly should be housed in CD caddies. Caddies are polystyrene or acrylonitrile-butadiene-styrene (ABS) protective holders that contain many CDs for juke boxes or player auto-changers.

3. Don't stack CDs into long term storage permanently. Check CDs for delamination and information loss at yearly intervals.

4. Don't use CDs for long term storage without keeping at least two copies of any hardware or software necessary for access.

5. Don't allow CDs to lean within their storage systems; keep them upright.

DISASTER MANAGEMENT PLAN FOR ARCHIVES, LIBRARIES AND MUSEUMS

Disaster means a great or sudden misfortune or terrible accident. This in the case of archives, libraries or museums can be flood, heavy leakage in the roof of a building, infestation with biological agents, fire, an earthquake, other man-made problems such as religious war, bombing, theft etc. Disaster can be natural or man-made. What ever may be the type of disaster, when occurs, it is very difficult to safeguard the manuscripts, books, records, antiquities and human beings in the organisations. Therefore a disaster management plan is required for institutions to handle the disaster before, while and after its occurrence.

A Disaster Management Plan

Disaster Management Plan is very important for cultural institutions. It makes the staff aware of the various possible disasters in an institution, its prevention procedures, training in disaster management, after disaster procedures in case of manuscripts and other objects. In the middle of the 20th Century, the discipline of Disaster Management was in a nascent state in our country. At that time, Disaster Management consisted of Flood and Drought Management. Chemical and industrial disasters were new. The Bhopal tragedy had just then struck, but preparedness was a new experience. The disaster management in archives, libraries, museums and other cultural institutions as any disaster will be disastrous to the materials as the lost materials will not be available for posterity. Therefore it is very essential to have a disaster management plan, team etc.

Description of a Disaster Plan

A disaster plan is a document which describes the procedures devised to prevent and prepare for disasters, and those proposed to respond to and recover from disasters when they occur. The responsibility for performing these tasks is allocated to various staff members who comprise 'the disaster team'.

Disaster Preparedness Plan

Having a Disaster Preparedness Plan means an archives, library or museum has implemented action to prevent disasters from occurring and has prepared by developing the necessary procedures to effectively respond to and recover from a disaster when it does occur-thereby reducing the impact on the staff, the collection and the archives, library or museum. It is a

document containing information on the Standard Operating Procedure to be adopted in an emergency due to any disaster. By its comprehensive nature, it saves the time used in thinking in emergencies. With training drills it ensures quick response of the people involved. It does not respond to emergencies – it is people who do that. It ensures that staff is familiar with the plan and their roles in it, and that they have the resources, training, and authority to undertake their duties and responsibilities. This information has to be made up-to-date and the Plan practiced regularly. Emergency preparedness does not stop once a written Disaster Management Plan is completed.

Disaster Response Team

Disaster Response Team should be organised in an institution. It should have the Co-ordinator, Conservator, Civil Engineer, Electrical Engineer, Fire Officer, Revenue Officer, Police Officer, Health Officer etc. They should be given specified duties and meet regularly to review the situation in the institution.

Allocation of Responsibilities

The broad ranging nature of a disaster plan results in the involvement of many staff. Some of the tasks likely to be identified and the corresponding staff who could be responsible for their implementation should be clearly spelt out. Everybody who has a role to play in the preventive and preparedness phase should be identified and their responsibility clearly stated.

The duties of the Disaster Response Team are multifarious. They are

- Declaring emergencies and implement the Emergency Plan.
- Implementing evacuation procedures.
- Contacting emergency services (fire, police, ambulance) and utilities.
- Establishing a command post, chain-of-command and reporting procedures.
- Accessing and stabilising the environment.
- Assessing emergency services, supplies and equipment.
- Obtaining emergency services, supplies and equipment.
- Ensuring the safety of staff and volunteers at all times during emergency.
- Arranging for off-site storage and work facilities.
- Arranging the transfer of collections to a safe site.

- Recording the movement of collections .
- Contacting, deploying and supervising staff of the archives, libraries or museums.
- Implementing and supervising salvage procedures of collections.
- Contacting, training and supervising volunteers.
- Documenting all aspects of the response / recovery procedures.
- Signing purchase orders.
- Meet with the press.
- Preparing post-emergency reports.

Emergency Plan

I. Authority Statement

When there is a disaster, the Head of the Institution authorises its staff, employees and volunteers to meet the emergency. The head of the institution's Disaster Response Team is vested with the authority to declare a state of emergency and to use appropriately whatever resources are necessary.

II. Policy Statement

During a disaster, the archives, library or museum declares its priorities to be

1. Protection of life
2. Protection, recovery and stabilisation of the collection of records.

For achieving this alone, it authorises the bypassing of normal procedures.

III. General Instructions

1. Wherever necessary, visible emergency exit signs must be posted clearly.
2. On hearing an alarm or information from the staff all persons shall evacuate the buildings of the archives, libraries or museums.
3. Copies of the Emergency Plan should be available readily for the Disaster Response Team.
4. The Disaster Response Team has authority in all practical matters for the duration of the emergency.

Appendices

There should be details of information as required below to take swift action during any disaster:

1. Complete staff list with addresses and phone numbers.
2. Emergency Response Team call-out list with phone numbers (Check weekly).
3. Public emergency services phone numbers (Check annually).
4. Phone and fax numbers, e-mail IDs of other sources of emergency support and appropriate Public Works authorities (Check annually).
5. Phone and fax numbers, e-mail IDs and addresses of local suppliers of equipment, materials, freezing services, ambulance, accommodation and services that might be required (Check annually).
6. Building information, with plans showing location of water, electrical, gas and compressed air circuits and all switches and cut-offs (Update annually).
7. Lists of emergency equipment and materials held in stock with quantities and location (Check stock and update monthly).
8. Lists and locations of fire fighting equipment and first aid supplies (Check monthly and update monthly)
9. Location of safe copies of Collections' Records and Disaster Plan.
10. Distribution of Disaster Plan in every room; Phone numbers of the members, suppliers etc., beside every telephone instrument.

Signature of Head of Institution & Date

How to Avoid Failure?

Having gone to the trouble of preparing a disaster plan, it is important to revise it frequently and to ensure that all staff are familiar with its contents. One of the best methods of maintaining staff awareness is to practice the plan regularly.

FIRE

Fire is the resultant of the combination of fuel in the presence of air at a particular ignition temperature. When fire is supported by oxygen it has flame. It spreads immediately. In

archives, libraries and museums there is a likely hood of fire as the contents are mostly organic in nature. Once fire starts, it is difficult to save those materials, which got fire. Because of the organic nature, archival materials get fire. The other causes of fire are electrical faults, smoking inside the buildings, using inflammable materials, carelessness etc.

Fire/ Smoke Detecting Devices

It is very important to detect smoke or fire inside archives, libraries or museums in order to take immediate steps to stop spreading of fire. Nowadays, many smoke/fire detecting devices are available, which can detect smoke/fire inside the buildings where such devices are installed, thereby fire will be detected and action taken to extinguish fire. Heat detectors, smoke detectors, fire detectors, laser fire detectors etc., are available today for this purposes. When fire starts in a building, automatic water sprinklers will start functioning in case they are installed. In European countries especially in the UK if there is no proper fire detection and fighting devices fixed, no permission is given for the establishment of such an institution. The floors are also marked with red fluorescent paint giving the direction where the staff and public should go to the exit at an emergency. If there is any emergency exit the lock should be tested frequently and the availability of key should be known to all the staff who is working in the area.

In the Indian context, it is right to mention here that the National Museum, New Delhi, the National Archives of India, Government Museum, Chennai, Salar Jung Museum, Hydrabad etc., have got good fire detecting facilities. Even though all the archives, museums and libraries are provided with fire fighting equipment, their maintenance is not to the expected standard. It is better to check their working condition periodically so that they may be utilised at the time of emergency. All the staff should be trained in fire fighting. When fire is noticed all action should be taken to contain the fire immediately. The fire services should be contacted immediately by dialing 101, which is toll free. When one contacts the fire services, it should be remembered that the contacting person should give the place, locality of the place where fire has occurred, phone number, land mark of the place etc., enabling the fire tender reaches the place quickly before fire spreads. In the mean time, the fire should be attended with the help of the various types of fire extinguishers available with the institutions. If fire extinguishers are not kept in the institution, it is an offence.

Fire Extinction

Fire Extinction

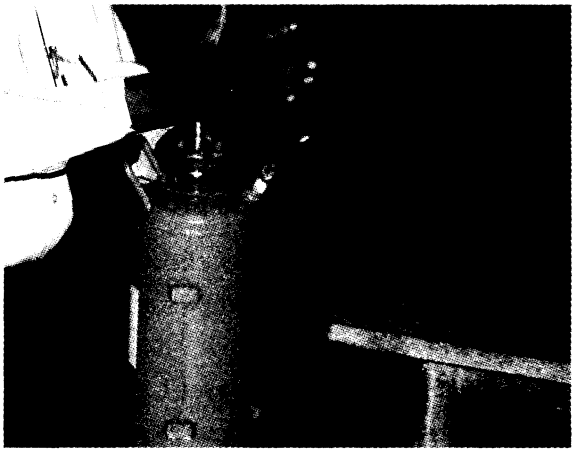
Fire may start in archives, libraries, museums etc., due to various reasons. If the reason for fire, type of fire, etc., is known it is easy to extinguish the fire. Therefore, it is rather very important to know the characteristics of fire. Fire needs ignition temperature, flammable material and a supporter of combustion i.e. oxygen. If all the three or at least one is cut off, then the fire automatically extinguishes.

Categories of Fire

There are different types of fire extinguishers depending on the type of fire. The principle involved in a fire extinguisher is either to bring down the combustion temperature, to cut oxygen supply by making a cover around the combustible material or to remove the combustible material away from the fire.

Recently impulse fire extinguisher is available in which two cylinders containing water and air are used to put out the fire by triggering the gun attached to it.

Foam type fire extinguisher is suitable for extinguishing the fire (type B) on the inflammable materials. It forms lather and covers the materials, which catch fire. The gas produced in this device is not good for health and therefore its use is not much advised. It is banned by the government. Dry chemical fire extinguisher is also good for extinguishing all types of fire. Water carbondioxide fire extinguisher is suitable only for the type A fire and it should not be used for the fire due to electrical faults, as this will risk the user, as electricity will be conducted to the user through the water released from the extinguisher. Halon type fire extinguisher contains Bromo chloro difluoro methane. This is also not good for human health and hence its manufacture is banned.



Demonstration of Water-Carbondioxide Type Fire Estinguisher

Dry Chemical Powder fire extinguisher is good for all the fire except type A fire. This contains Sodium bicarbonate powder and it is pushed out with the help of carbon dioxide stored inside. ABC powder Fire Extinguisher is good for all the three types of fire. This contains mono ammonium phosphate powder and this powder is pushed out with the help of stored

carbon dioxide in cartridge inside the fire extinguisher. Therefore, it is highly essential to provide the fire extinguishers, which can extinguish all types of fire in archives, libraries, museums etc. When the fire extinguishers are fixed, it does not mean that the materials will not catch fire or in case of fire, fire will be extinguished automatically. It is highly essential to teach about the working of the fire extinguishers and fire fighting methods to all those who are working in the archives, libraries, museums etc. There should be a fire alarm, as this will facilitate the evacuation of the staff and public to safety. It should be borne in mind that the fire fighting devices should be maintained very well and they should be checked for their workability quite often. The chemicals inside the fire extinguishers should be changed at proper times. The fire officer's advice should be sought often. When there is symptom of fire, the fire extinguisher should be removed from the fixture, the clip should be removed from the top rod. The rod should be pressed against the ground or with hand. Then holding the tank properly with left hand and the host is directed towards the fire. The powder comes out with pressure and extinguishes fire as it covers the flame keeping starvation to the fire. The fire services should be informed by dialing 101. When information is given one should tell the phone number, location, land mark etc., within two minutes. The fire service personnel will call in the number and only after confirming the fire tender will come for the rescue.

Protection from Fire

As fire destroys very easily archival materials, books, manuscripts, photographs etc., fire can be averted in archives, libraries, museums etc., by resorting into proper fire preventive methods. Smoking should be prohibited strictly inside the stack area or in the galleries.

1. Inflammable materials should not be stored inside the stacks. The inflammable chemicals should be kept separately in the laboratory that too away from hot plates etc.
2. The electrical defects and faults should be set right then and there. The electrical wires should be changed as per the norms prescribed by the electricity rules. After office hours the electrical mains should be switched off. If possible separate main switches may be provided for each stacks or room.
3. The buildings of archives, libraries, museums should not be linked with other buildings. The buildings for archives, libraries, museums etc., should be separate.
4. The waste and other materials like packaging materials should be kept separately away from archival materials.

5. Entries into the archives etc., should be checked for avoiding bombs, crackers and other harmful materials inside.
6. Under any circumstances inflammable materials should not be allowed inside the stacks etc. Open fire should never be used.
7. In case of fire, alarm should be raised.
8. The telephone number of the Fire Office should be clearly and visibly exhibited. The number is 101.
9. Location of fire extinguishers and hydrants should be indicated for easy access to them in the event of eruption of fire.
10. Location of emergency gate or door should be clearly indicated and the locks should be in working condition.

Accidents

Archival materials greatly get destroyed because of natural calamity. Flood, fire, cyclones, earth tremors etc., include calamity. The wrong handling also results in accidents. The ignorance of handling also brings forth accidents. Crowded storage, improper storage etc., results in many accidents to the archival materials, manuscripts etc. Sometimes, miscreants damage the paper materials very badly. One of the examples is the incident which happened in the Bhandarkar Oriental Research Institute, Pune where the almyrahs and furniture etc., were damaged in arson. Fortunately the manuscripts are safe.

Flood

Due to heavy rain and because of the leakage and seepage water may damage archival materials. Sometimes flood also may enter such buildings because of heavy rains and breach of dams etc. When fire extinguishers are used to extinguish fire, or water pipe lines are damaged archival materials, manuscripts, etc., are seriously damaged. Art papers stuck together and blocked and the separation of such stuck papers becomes very difficult. When flood or water affects the archival materials, they should be dried by proper ventilation, fumigated and damaged materials should be restored. Stagnant air should be exhausted and fresh heated air should be circulated. Dehumidifying the room helps in the removal of moisture. Keeping all the windows open and providing fan helps to have a dry climate. A 10% thymol in methanol may be sprayed on archival materials or manuscripts. Highly water affected archival materials may be subjected to freeze drying at -20° to -30°C and the water present in the material reaches solid state and gets vapourised and therefore no water stains are formed.

Whatever may be the methods followed, the human involvement in the protection of records, manuscripts etc., is the need. Monitoring and proper handling of the situation will take care of the records and manuscripts.

Theft

Archival materials, manuscripts, records etc., have been stolen from archives, libraries, museums etc. The theft is due to improper guarding. This may happen in connivance with the staff or without the staff. Checking of the materials only will be able to disclose the loss. The loss should be intimated to the police and FIR should be registered. Digital records of archival materials, manuscripts etc., will help to retrieve the lost materials. On any account, bags of visitors should never be allowed. Movement register should be prepared and entries should be made when ever manuscripts are taken out and brought in.

Conclusion

Disaster planning is becoming an essential component of the overall management plan for a library or archive. The importance of an effective disaster plan is regularly demonstrated in institutions which are strongly committed to their plans. There is ample evidence to indicate that to be effective, a plan must be incorporated into the day-to-day management of an institution. A well thought out and presented plan is useless if it exists solely as a document on a shelf. A checklist is a must to assess the condition of the damage occurred to the property. A Conservator may be summoned to advice, if necessary. There are many conservation procedures to rescue the affected manuscripts and art objects. Curators, Archivists, Librarians and the Collection Managers, Keepers, Caretakers etc., concerned may contact the suitable persons for the conservation of affected objects after the recovery of the objects are made.

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About the book....

This book, Care of Archival Materials and Manuscripts, deals with the history of writing, records and manuscripts on bark, records and manuscripts on parchment, records and manuscripts on palm-leaf, records and manuscripts on paper, lamination of records and manuscripts on paper, records and manuscripts on bamboo, records and manuscripts on ivory, records and manuscripts on textile, photographs, negatives, and other modern documents, writing on clay tablets and potsherds, records and inscriptions on stone, records and manuscripts on metal, digitization of records and manuscripts, storage of records and manuscripts, disaster management in archives, libraries and museums and bibliography. This book will be an useful tool to those interested in the conservation of records, manuscripts, books etc.

About the Author...

Dr. V. Jeyaraj, born in 1950, is a post-graduate in chemistry and history. He is a doctorate from the University of Madras in conservation. He joined the department of museums in 1976 after serving a few years in a school and college. He headed two district museums in Erode and Vellore as Curator for about 7 years and as Curator for Conservation over 22 years. To his credit he has over 150 research and popular articles both in English and Tamil in conservation, anthropology, archaeology, numismatics, museology etc. He has written over 20 books such as guide-books, books on conservation, museology, numismatics etc. He has given many invited lectures both in conservation and museology. He was the President of the Indian Association for the Study of Conservation of Cultural Property, New Delhi (2000 to 2005) and he is the Editor of the Journal, Conservation of Cultural Property, New Delhi. He is also the Editor of the magazine, Nunkalai. He is the Coordinator of the Government Museum Manuscripts Conservation Centre, Chennai (NMM), member of the ICOM, Life Member of organisations such as Museums Association of India, South Indian Numismatic Society, Association of British Scholars, Tamilnadu Archives Records Search Committee, Member, Board of Studies, Cochin University, Kerala. He is a Ph. D. research supervisor under the University of Madras. He has visited countries like United Kingdom, France, Germany, Australia, Singapore to study the current museum policies and practices in conservation, museology, education etc. He is associated with many research projects with many organisations like Indira Gandhi Centre for Atomic Research, National Mission for Manuscripts, Anna University etc.